A NON-SILVER MANUAL

Cyanotype, Vandyke Brown, Palladium & Gum Bichromate
with instructions for making light-resists including pinhole photography

by

Sarah Van Keuren

with

GUM PRINTING ON ALTERNATIVE SURFACES by

Dana Leight

New in this edition:

DESKTOP NEGATIVES by

Sandra C. Davis

INSTRUCTIONS FOR COPY CAMERAS by

SVK, Sandra C. Davis, & Stuart Goldstein

ONE INTERPRETATION OF GUM PRINTING by

Melissa Good

CASEIN PRINTING by

Rosae Reeder

Third Edition 2004, 10th Revision 2010

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PREFACE

This manual is intended to reinforce and supplement classroom instruction but may also assist artists outside the classroom who are already committed to working in non-silver processes. It originates from a collection of handouts that I wrote for non-silver students at The University of the Arts (formerly the Philadelphia College of Art) in the 1980s and early 90s. My explicit descriptions of processes are not put forth as *the* way but rather as *a* way that has worked for students and myself. It is one of the pleasures and rewards of teaching to see students finding their own ways — and to learn from them!

A Body of Knowledge

You might expect that non-silver processes from the 19th century would comprise a static body of knowledge but I have not found that to be the case. In 1977 when *Breaking the Rules: A Photo Media Cookbook* by Bea Nettles was published, her slender volume was the definitive printed word on the topic of non-silver. When *The Keepers of Light* by William Crawford was published two years later it seemed positively encyclopedic. Little did I imagine that cyanotype, which occupied a bit more than one page in Nettles' book and 6 pages in Crawford's book, would by 1999 be the subject of a fascinating 178 page book titled *Cyanotype: The History, Science and Art of Photographic Printing in Prussian Blue* by Dr. Mike Ware. Recently we had the luxury of a periodical devoted to all aspects of non-silver, namely *Post-Factory Photography* published by Judy Seigel.

My introduction to pinhole photography was Jim Schull's little book of humorous drawings, *The Hole Thing*, published in 1974. *Pinhole Journal*, edited and published by Eric Renner and Nancy Spencer delighted and educated for over two decades, and Eric's in-depth *Pinhole Photography: Rediscovering a Historic Technique* is a major reference Within the past few years, two new comprehensive, handsomely illustrated volumes, *The Book of Alternative Photographic Processes* by Christopher James and *Photography's Antiquarian Avant-Garde: The New Wave in Old Processes* by Lyle Rexer have contributed to our understanding and appreciation of non-silver.

And what, you may ask, would be the place of my small, un-illustrated, self-published manual within this wealth of new literature on non-silver? I don't know the history of non-silver processes as well as Christopher James does nor do I know about as many processes as he does. And I don't have the perspective on the contemporary art scene that Lyle Rexer demonstrates. Certainly I don't know chemistry or the history of science the way Mike Ware does. Judy Seigel's deep knowledge of the field of alternative processes cannot be matched.

What this manual does offer is a body of practical knowledge gained from my experience as artist and teacher as well as the practical knowledge of those who generously contributed to this new edition. I have covered what I have been able to do within the constraints of a modest lifestyle with modest facilities. And I have been able to teach the contents of this manual to others within the limits of weekly 6-hour studio classes over the course of two semesters. The un-ambitious scope of this manual may be its strength.

What's New in the Third Edition?

The text of this manual has undergone many revisions during the 30 years that I have been teaching non-silver processes in the Printmaking studios at UArts. For this Third Edition I went over the entire text, modifying and expanding it in accordance with what I learned in the past several years. As continuous-tone sheet films are phased out and we move into the digital age in earnest, I have tried to find ortholith film and digital ways to produce the tonal range those films provided. In this 10th Revision I updated all of the chapters that I wrote. There are many changes.

A chapter by Rosae Reeder on casein printing, and a page by Melissa Good on her way of printing in gum bichromate from digital negatives are new in this 3rd edition but have not been changed in this revision. Sandra Davis's contribution and the chapter on copy cameras that are new in this edition have been updated in this revision.

Acknowledgements

For their help with this manual in its earlier stages I want to thank Dana Leight, who, as a graduate student and teaching assistant, encouraged me to self-publish. Her page on surfaces to print on besides paper has stood up over time. Thanks also to the late book artist Enid Mark who critiqued my initial text and part of this one. Going back in time, thanks to Lois Johnson, Patricia Dreher and the late Jerome Kaplan, for introducing me to non-silver processes in the mid-1970s and to Phil Simkin for getting me started with pinhole photography and later my first computer. Thanks to the University of the Arts for awarding me four Venture Fund grants that helped support research in preparation for the writing of this manual and for providing workshops and classes to bring the faculty up to speed with computers. Most sincere thanks to Harris Fogel, in Media Arts/Photography at UArts for his generous support in my quest to make digital negatives to print in non-silver and for his help in the production of this edition. Thanks to Sandra Davis, Stuart Goldstein, Melissa Good, and Rosae Reeder for their

contributions to this third edition. I am especially indebted to Stuart Goldstein for his help in editing the new and expanded text of this edition. And thanks to my partner Harry Kalish for his continuous support.

Finally, thanks to the non-silver students, undergraduate and graduate, matriculated and non-matriculated, who have used these antique 19th century processes to convey their late 20th/early 21st century visions. They have given me an expanded understanding of the range of expression inherent in the processes described in this manual.

Warning

There is an environmental price to pay for the alchemy that takes place in the production of non-silver images. Less toxic means of expression should be exhausted first (especially by people whose homes have septic tanks).

Some of the metallic compounds and certain other chemicals used in these processes are potentially hazardous to the printer. As a general rule, children should not be taught non-silver processes because of the risk of skin contact and inadvertent ingestion of the chemicals. Even adult classes should be small and closely supervised to ensure safe practices. A student should not be required to take a non-silver class if he or she has no interest in the processes. Students in my classes sign a contract in which they agree to adhere to explicit safety guidelines.

Basic Principle

The non-silver processes covered in this manual rely primarily on the energy of light rather than the energy of chemicals to produce a print. This light, referred to as actinic light, is rich in ultraviolet and blue rays. In the 19th century the only source of actinic light was the sun. Where actinic light strikes paper coated with one of the non-silver solutions or emulsions for a sufficiently long time, a chemical reaction occurs and the coated paper darkens or takes on a different color. Where actinic light is prevented from reaching sensitized paper, the chemicals wash out leaving plain paper. Where light is partially prevented from striking, a tone is produced that is somewhere between the darkened paper or changed paper and the original color of the paper.

The ways of making light-resists discussed below produce white shapes or marks on a dark ground — with the exception of 'Opening Up Lines'.

Possibilities

3-D Photograms: The most direct way to produce an image is to lay objects upon the sensitized paper. This is a variety of photogram. A point light source, such as the sun in a clear sky or an old-fashioned sunlamp, casts shadows from standing objects that print clearly. A diffuse light source, such as an overcast sky or an array of black light tubes, eliminates delineating shadows revealing only the 'footprint' of the object on the paper.

Partially translucent objects allow varying amounts of light to penetrate to the sensitized paper and produce intermediate tones. Such tones can be produced also by moving opaque objects during the exposure.

Flat Photograms: Materials that can be pressed tight by plate glass against sensitized paper — such as botanical specimens, tissue, wisps of cotton, locks of hair, lace, onion skin, cheesecloth, and translucent printed matter — produce light shapes in various tones on a dark ground. When using damp photogram materials such a fresh leaves or flowers, if you want to prevent chemical reactions or staining, insert a layer of clear acetate between the coated paper and damp materials. To permit multiple printings of a particular arrangement of photogram materials you could tape or glue photogram materials to the acetate. You could also compose a number of related photograms on acetates to print in successive layers of gum bichromate colors or layers of other non-silver processes.

Markers, Washes & Colored Pencils: The same clear acetate may be drawn on with rubylith or amberlith AD markers. Red and orange dyes in these markers block actinic rays. The inks in other markers, such as black, brown or red Sharpies, are not designed to hold back light very effectively. Blue and green markers definitely allow actinic light to penetrate and are the least effective light resists.

In 2001, Faber-Castell introduced Pitt Artists' Pens in black, sepia and sanguine — all permanent, acid-free India inks that do block light effectively. Each of the three colors comes with 4 different nibs including a versatile brush nib. Artist Mary Laniel Nakigan used the 3 colors to draw registered acetate separations to print in 3 gum colors with great success. Since about 2005, Pitt Pens have been available in a wide range of colors that could be used to block varying amounts of light, and now a new large nib is available.

Photo opaque, acrylic paint, and various inks and watercolors can be strong light-resists when used full-strength but washes of these materials diluted with water bead up on the slippery surface of regular clear acetate. Rosae Reeder recently told me that you can add a drop of a surfactant such as Photo-Flo or even liquid detergent to reduce surface tension and allow such materials to adhere. There are also certain more expensive clear acetates that are treated to accept washes. Frosted acetate, frosted mylar, and tracing paper will accept washes in photo opaque, Plaka, Pro-Color, and acrylic paint. Inks and watercolors can be tried on frosted acetate or mylar, perhaps with a drop of a surfactant, but with no guarantees. Tracing papers, especially sturdy vellums, tend to take washes easily but their density prolongs exposure time onto papers sensitized with non-silver processes, especially when printing in relatively slow cyanotype. Graphite, crayons, and colored pencils in the black-sepia-sanguine-orange range can be used on the frosted materials and on tracing paper or vellum for light-resists.

If dark figures on a white ground are desired, a contact negative must be made (unless you have been clever enough to draw a negative). A contact negative can be made in a darkroom by placing the photogram object(s) or drawing in contact with sheet film or photographic paper, exposing and developing it appropriately, and then using the resultant 'negative' to produce a *positive* non-silver image.

Opening Up Lines: Sheets of rubylith or amberlith masking film can be used to create high-contrast light-resists. Film-cutting tools provide an easy way to open up lines on masking films that will then print dark on a white ground.

If you should accidentally fog a sheet of black-and-white film, don't throw it away. Instead, expose it completely to daylight or artificial white light, develop, stop, and then wash it—no fixing should be necessary because there is no unexposed silver salt to dissolve out. The resultant black sheet can be scratched on the duller emulsion side with a sharp tool such as an etching needle. Dampening the emulsion side of the film with a sponge or paper towel allows smoother removal of the metallic silver by scratching and even permits a degree of tonal gradation with a tool as primitive as your fingernail. You may want to try this on actual negatives too. Scratching on the film can be a bold way of saving an overexposed or fogged pinhole negative or copy/view camera negative.

Cliché-verre is a late 19th century ancestor of the scratched films described above. A group of French artists, referred to as the Barbizon School, that included Corot and Millet, worked directly from nature and made drawings with etching needles on opaqued glass that they printed in gum bichromate and other processes. The resultant images, resembling etchings, were called *cliché-verres* (repeatable glass prints). Traditionally, glass was opaqued by holding it over a lantern and allowing soot to darken it, or by brushing brown hard-ground (used on etching plates) onto the glass. Today some printmakers still use hard-ground but various modern water-soluble materials seem to work even better because they don't offset on the printing paper, melt under hot lights, or involve the use of solvents. It is not necessary to opaque an entire sheet of glass; it may be coated partially or in painterly brush strokes. Some of my students have included photographic negatives upon the glass, opening opaqued areas with a single-edge razor and attaching the film to the coated side with a few drops of gum arabic that can be washed off the film later. To obtain a sharp image a cliché-verre must be printed with the drawn side in contact with the sensitized paper. (This means that your image and text will be laterally reversed.) Otherwise, light will spread as it passes through the thickness of the glass and the image will be blurred, though a softened image may be preferable sometimes. One could draw with a focal plane in mind on one side of the glass and then draw on the other side in lines and shapes that will print out of focus. As is the case with etchings, cliché-verre plates can be reworked, filling in some areas and opening up others to produce different 'states' of the image. These states can be printed in different layers of non-silver processes if desired.

CYANOTYPE

In England in 1842, just three years after the official invention of photography, Sir John Herschel coined the word 'cyanotype' (*cyan* from the Greek for blue and *type* meaning print) for a process he invented in order to make copies of his astronomical calculations. His friend Anna Atkins learned the process from him and in 1843 produced a volume of photograms of British algae that is now recognized as the first photographic book. Looked down upon in the 19th century as a vulgar means of cheap reproduction, the blues and other hues of cyanotype are now treasured for their vibrancy and permanence.

My grandmother, over one hundred years ago, learned about the masterpieces of European painting through cyanotypes (contact-printed from view camera negatives) that were distributed to her high school class. Her set of cyanotypes, still in excellent condition, was glued into several notebooks and surrounded by her handwritten notes. It must have been a shock for her when eventually she saw the paintings in color. Some of these early reproductions are mournfully appealing in their fine blue complexity.

The cyanotype process is based on the fact that upon exposure to sunlight or other actinic light, ferric ammonium citrate, a light-sensitive iron salt, is reduced to the ferrous state and turns blue in the presence of another iron salt, potassium ferricyanide.

Part A: The first part of the cyanotype solution is **ferric ammonium citrate.** (see under ArtChemicals.com in "Resources"). This iron salt is not especially toxic and was in fact prescribed long ago as a dietary iron supplement. The kind that we use is a bright green, almost chartreuse, powder that should come in a light-proof brown jar (or be stored in darkness) with a tight-fitting lid to prevent moisture from turning the hydrophilic light green powder into a sticky and, later, hardened dark green glob.

To prepare this part of the solution, pour 8 ounces of distilled water into a wide-mouthed container. Carefully spoon 50 grams (a little less than 2 ounces) of the powdered ferric ammonium citrate into a paper 'boat' on a scale and then pour the iron salts into the distilled water slowly, stirring as you pour. After a week or so a moldy scum will begin to form on this solution. In the early stages, it can be ignored with no ill effects in printing. Later it can be lifted or strained out of the solution. You can prevent the mold from getting started in the first place by adding a few drops of formaldehyde to the solution, but formaldehyde is toxic and, unless it is already on hand for other purposes, it might be wiser to do without it in a home studio and to strain the solution instead.

Part B: The second part of the solution is **potassium ferricyanide** which turns blue where it is in contact with ferrous ammonium citrate. Since potassium ferricyanide (not to be confused with potassium ferr*o*cyanide) is a commonly used bleach for black-and-white films and prints, it can be bought at well-stocked photography stores or ordered via the internet or by phone (see "Resources"). This chemical is caustic and potentially more toxic than the ferric ammonium citrate. It should not be combined with acid because cyanide gas could be released. There are varying opinions among chemists and safety experts as to whether cyanide gas is released during the exposure to actinic light of a surface sensitized with cyanotype chemistry. Most think that it is not a problem, but to be on the safe side, step back when opening a contact frame in which a cyanotype has been exposed and do not inhale the fumes that float off the hot print.

You now have the two components of the cyanotype process which, when stored separately, will last a few years. However, if you combine the two components, the complete solution is useable for a day at most. I store my A and B solutions in recycled plastic bottles with dispenser tops. I opaque the bottles with black photographic tape and put a patch of white tape over the black on which I write the name of the chemical, a big A or a big B, and the date each solution was prepared.

To summarize:

Part A: 50 grams ferric ammonium citrate in 8 ounces (236 ml) distilled water
optional: add a few drops of 37% formaldehyde to prevent mold

Part B: 35 grams potassium ferricyanide in 8 ounces (236 ml) distilled water

Combine parts A & B in equal amounts when you're ready to use it.
Use all of the complete solution within 12 hours or less.

Printing Surfaces

Cyanotype prints well on organic materials such as cotton, silk, linen, mulberry, and wood. It prints weakly, if at all, on synthetic materials. Contrast and sharpness vary depending on the surface of the material. A soft, unsized cotton paper such as BFK Rives will absorb a lot of the solution and, if given enough exposure, can produce a tonally rich print. On such a surface, apply the solution liberally and gently to avoid

raising little tufts of fiber that could lift off your print during development and washing, leaving a snowstorm of white dots on your image. Harder, less absorbent surfaces, such as Arches Platine or Strathmore 500, require less solution and render sharper detail. No added sizing is needed for any of these papers.

Preparing to Print

Before coating paper with cyanotype chemistry, place your light-resist upon the sheet of printing paper and lightly pencil its corners so that you know the boundaries of your image area. Or, since it is not necessary to adhere to a rectangular or square format, place the negative transparency beneath the printing paper on a light table and sketch the area or shapes that you wish to render in cyanotype. Try to avoid touching the image area of your paper, especially very smooth papers such as Platine or hot–press Strathmore 500, because greasy fingerprints can repel the cyanotype solution that you will apply.

Keeping Notes

It is my practice to write notes with an HB pencil along the edges of a print, usually on the image side so that I don't have to keep turning the print over to refer to them. Beginning in the lower left corner I note the kind of paper I am using, whether or not it has been preshrunk, and the title of the negative (with date if possible). Then I write down the first process to be applied to the paper. A typical note might read:

1) cyanotype in sun 5 minutes around noon 6/21/08

It is only by keeping careful notes that you can hope to repeat an image. During the printing process I feel I could never forget what I have done, but a week later it is difficult to recall if the cyanotype that printed so well, (now under hardened gelatin sizing and 5 layers of gum), was exposed for 5 or 10 minutes. If you can discipline yourself to keep notes, you will learn from every print you make and avoid repeating mistakes, wasting materials, and becoming discouraged.

Preparing to Coat Paper

When you are ready to apply the cyanotype solution, tape the corners of your printing paper to a clean, dry, smooth surface so that the paper doesn't slide around. Drafting

tape is ideal because it releases easily and will not tear the paper. Masking tape can serve the same purpose *if* you reduce its tack by repeatedly touching it to your finger or some other surface so that it doesn't pull off paper fibers when you remove the tape. When coating a thin paper that will curl upon itself and possibly mar itself as it dries, tape the paper to a piece of glass or plexi that can be slipped into the drying rack (or if you are drying it on a line, weight the lower corners with clothespins or make some other arrangement). When coating thin cloth or porous rice paper, tape the material to glass or plexi to prevent contamination of —and possibly from—the drying racks.

Combine the A and B parts of the cyanotype solution using the minimum amount you think you will need for this printing session so you don't waste any. More can be mixed quickly if needed. In a small graduated cylinder, combine the 2 parts of the cyanotype solution. Five milliliters of each chemical mixed together should be enough to coat 8″ x 10″ areas on 4 sheets of paper, depending on the paper's absorbency. The complete solution can be poured into a shallow container that will accommodate a brush.

Brushing on Cyanotype Solution

Dip a clean dry brush (any kind of brush as long as no metal comes in contact with the chemicals) into the greenish-yellow liquid, charging it fairly liberally, and apply the solution where you intend to sensitize the paper. In a class situation do not brush the solution all the way to the edges of the paper because then it tends to creep onto the back of the sheet, which contaminates the coating area and drying screens (or clothespins) as well as your fingers. Remember that even dry chemicals can offset onto your always slightly moist fingers and from your fingers they can offset again into your eyes, mouth, food, etc. Having a chemical-free border gives you a margin of safety, as well as space for notes, signature, etc. If you wish to have blue to the edges of your paper, you can print on a larger piece of paper with clear borders and then tear or cut it down to the blue when the print is finished and dried. Or if you are using a paper with special edges that must be blue you can tape the paper to larger sheet of glass or plexi that you put in the drying area. Please carefully clean the glass or plexi when done and return it to its home.

Use a dry sponge brush to soak up excess liquid you may have brushed onto your paper; otherwise, your final print might be streaky with white patches. Orange crystals of potassium ferricyanide form as puddles of excess solution dry and mask

actinic light, preventing it from creating Prussian blue on your paper. The result can be a white crystalline pattern, like frost on a window, just where you may have intended the richest blue to print. Perhaps you will find that you actually like this effect and will puddle cyanotype solution intentionally at times. Subtle puddling of cyanotype chemicals may be responsible for variations in the blue intensity of prints that have been given identical exposure times.

Dry the paper in darkness, with circulating air if possible. After about 10 minutes, go over both sides of the paper with a hairdryer. Avoid touching the coated surface with your fingers. The paper is dry if it looks flat, doesn't feel cool on the back, and flexes easily with a slight crackling sound. If the paper is not dry, your negative could be stained or bleached by the still damp cyanotype solution (potassium ferricyanide *does* bleach silver in addition to making Prussian blue). Try to expose coated paper soon after the brushed-on solution is dry, but, if necessary, it can be stored longer in low humidity. If there has been a delay in exposure of coated paper under humid conditions or if the paper is not completely dry, lavender tints may appear in image highlights and contrast may diminish. Often the lavender tints disappear as the cyanotype dries.

Exposure

For printing by inspection, hinge one side of your negative to the sensitized paper with 2 small pieces of clear tape so you can lift the negative to check the exposure (like turning a page in a book) without losing registration.

Cyanotype usually requires considerably more actinic light than the other processes described in this manual. My favorite actinic light source is the sun. It is free, clean, powerful, relatively safe, and fun to use. The best times for making sun exposures year round (at least in Pennsylvania) are between 10am and 3pm — and later into the afternoon in the summer months. An efficient exposure is achieved if you position your contact frame like a solar panel so that the sun's rays are perpendicular to the printing paper and travel the shortest distance through the glass of the contact frame. However, if you are using a windowsill you must leave the contact frame flat. Never risk the calamity of a contact frame falling out of a window!

It is a waste of time and energy to use tungsten photofloods to expose cyanotypes. Their predominant wavelength is yellow and cyanotype does not react to yellow light. What's worse, the heat from a photoflood may crack the glass of the contact frame. Unfiltered

blacklight bulbs are cool slow sources of actinic light. If you can find one these days, an old-fashioned 275w sunlamp bulb works also but takes even longer.

A pulsed-xenon or mercury vapor bulb in a platemaker (primarily intended to expose lithographic plates) is a powerful actinic light source but is not really intended for long cyanotype exposures (and, in the process, generates ozone that should be vented). The very expensive bulb may overheat and rupture unless given a chance to cool periodically.

Don't use an old-fashioned carbon arc unless you have very good ventilation. Potentially lethal carbon monoxide is released by the burning charcoal.

Exposure times with all of these light sources depend on the density of the negative and can vary greatly. A sufficiently exposed cyanotype should look grossly overexposed and solarized before development. If you sit outside and watch a bit of cyanotype on paper (that is brushed beyond the border of the negative) respond to the actinic light of the sun, you will see the greenish-yellow cyanotype coating turn aqua-green immediately. The coating then turns deep blue. If you stopped exposing at this point, removed the negative, and submerged the paper in water, most of the cyanotype solution would probably wash off the image area and, at most, you might be left with a faint blue border around your image. A strong deep blue print results when the most open parts of the negative, that are going to print the darkest blues, have solarized to light silvery purple or light greenish gray or even beige, depending on the kind of paper used. What will end up as the deepest blue areas should look lighter than the surrounding printed-out tones.

If you are in the habit of using a 21-step film scale in your margin and wish to print to step 11, expose until you see tones printed out through step 17 before developing in water where it will lose about 6 steps.

When exposing through continuous-tone film it is important to check underneath the film for signs of solarization rather than going by the color of the sensitized paper that is not covered by the negative. To give an example, when you're exposing a cyanotype using a film such as sheet Tri-X, you need to give twice as much exposure to get maximum density in the open parts of the negative as you do in the margins because of the inherent density of the film base plus the unavoidable chemical fogging that occurs on continuous-tone film. This extra density is referred to as *film-base-plus-fog*.

Development

Fill a tray with cool water for the preliminary washing of the exposed cyanotype. Slip your paper into the tray face up and rock the tray to make sure no bubbles are trapped on the print's surface. Lift the print with tongs or gloved hands and slide it back into the tray face down. Continue lifting and flipping the print, face up, face down, for at least 2 minutes. (Change the water in the tray every few prints to get rid of the chemicals that leach into the water as they release from the unexposed areas of the paper's surface.)

Transfer the print to a larger wash tray equipped with a tray siphon running fast enough so that it injects fresh water into the tray and pulls out used water from lower down, but not so fast that it buffets and crimps the print. A thick, soft paper such as BFK Rives, which absorbs chemicals deep into its fiber, requires longer washing than a harder, thinner paper such as single-ply Strathmore 500. Determining how long to wash the print requires judgment regarding paper strength, archival qualities, and water conservation. Certainly any paper is not sufficiently washed if water draining off the print is yellow instead of clear but there is no need for excessive washing that can actually remove some of the image as well as waste precious water .

Bleaching a Cyanotype

It is common practice to deepen the blue of shadow areas with a brief bleaching of the cyanotype — and perhaps, in the process, to retrieve overexposed details and clear foggy highlights. In the past we have immersed the cyanotype in a solution of approximately one part household laundry bleach (5% sodium hypochlorite) to 32 parts water. Because bleach tends to make paper fibers short and brittle, the print must be washed afterwards until you can no longer smell the bleach on the paper.

In Finland, sodium hypochlorite is considered so harmful to the environment that a prescription is required to obtain it. My Finnish friends suggested a dash of hydrogen peroxide as a safer alternative since it reduces to water instead of forming harmful chlorine compounds, has no fumes, and is gentler to paper fibers. I found that peroxide had the advantage of deepening the blue of the most exposed parts of a cyanotype without bleaching away any highlight detail. I have since read and then seen for myself (to my embarrassment) that peroxide simply gives us a preview of how the cyanotype will look when thoroughly dry — which is a darker blue than when first developed and wet.

In my search for a kinder, gentler bleach, I have Judy Seigel, editor of *Post-Factory Photography*, (see "Resources"), to thank for letting me know about bleaching with odorless and more effective sodium carbonate, commonly known as soda ash and available in the laundry section of grocery stores as 'washing soda'. I have not yet determined its effect on paper fiber but suspect that it is less destructive.

Prolonged immersion in either sodium carbonate or sodium hypochlorite takes a cyanotype back through color changes that the print went through during exposure, but in reverse order. You may stop the bleaching process at any shade of blue, green or yellow that you fancy by pulling the print from the bleach tray and plunging it into a tray of water. A continuous-tone image will often bleach into a split-tone with gray highlights and blue shadows or yellow highlights and green shadows. This occurs because the bleaching has more impact on the thin highlight passages than in the denser shadow areas.

Richer bleached colors result when you overexpose onto a soft paper such as BFK Rives which absorbs more of the cyanotype solution than a hard paper such as single-ply Strathmore 500.

Toning with Tannic Acid & Sodium Carbonate

During prolonged bleaching, the lighter tones disappear first and eventually the entire image will turn a pale yellow or gray or vanish. These lost tones can be restored in a rosy-brown color by putting the bleached cyanotype in a tray of water laced with lithographer's tannic acid, a light brown powder (see Bostick & Sullivan in "Resources") that smells like instant tea mix. In the past we used to bleach cyanotypes in household bleach (sodium hypochlorite) and then bring back the image in tannic acid.

If you are using sodium carbonate as your bleach the instructions seem counter-intuitive but it works to immerse the print briefly in tannic acid (about $1/2$ teaspoon to a quart of water) and then in sodium carbonate (about $1/2$ teaspoon to a quart of water) and then back into the tannic acid and on to a preliminary wash tray and a final wash tray.

Wear gloves when handling the jar of powdered tannic acid and when toning prints in a tray of tannic acid in water since it stains the skin. The darkening action of tannic acid continues during the washing and *drying* of the print. Through experience you'll learn to remove your print from the tannic acid bath before reaching the desired effect.
If you are using a continuous tone negative, a duotone image with rosy brown highlights and blue shadows can be gotten with partial bleaching and toning.

Discard the tray of tannic acid at the end of the toning session. It does not keep well. You can discard the tray of sodium carbonate too.

According to the artist Enid Mark, the tannin in strong cheap tea will give a warmer tone than tannic acid. She has applied bleach selectively (she used household bleach but you might try sodium carbonate) and toning with tea to achieve 'local' color within a print. A dry cyanotype on a flat surface can be brushed selectively with bleach and then flooded with water so that the bleach is washed out but the surrounding areas are not affected noticeably. Applying bleach to a damp or even a wet cyanotype will give softer edges as the bleach bleeds into surrounding areas. A slow transition, or gradient, from deep blue all the way to yellow can be achieved by immersing the part of the print to be lightened in a bleach bath and moving it skillfully to avoid 'lap' marks. Having the print damp to encourage capillary action helps to soften the effect here too. The same strategies apply to the application of either tannic acid or strong tea in areas that have been bleached to restore the original cyanotype image but in brownish tones. You should be warned that tannic acid slightly stains the white parts of a cyanotype image. Strong tea is even more likely to discolor highlights; after all, it has been used for a long time to tint white lace and crocheted doilies.

Deconstructing Cyanotype

I highly recommend *Cyanotype: The History, Science and Art of Photographic Printing in Prussian Blue* by Dr. Mike Ware's (see "Resources"). After reading it, I began to experiment with the components of cyanotype, attempting an artist's deconstruction of the medium.

The most interesting result came from coating paper with Part A, the light-sensitive ferric ammonium citrate, alone. Exposing the coated paper to actinic light through the negative produced a tan rendition of the image, which washed off the paper entirely in water. But if, instead of developing in water after exposure, Part B, potassium ferricyanide, is selectively brushed on the Part A rendition, the image instantly turns blue wherever the brush touches the image area. As you slip the paper into the tray of water, a fine veil of blue may appear where potassium ferricyanide drifts across parts of the image that you didn't brush it onto. This delicate effect can be controlled by the flow of the water. A few students experimented with this way of working. There was some notable success mixed with a little disappointment that the blue wasn't quite as vibrant as it is when Parts A & B are mixed, applied, and exposed together.

All non-silver processes require light-resists or negatives that are the size of the final image. A darkroom enlarger does not project enough actinic light through a negative to even begin to expose paper coated with cyanotype solution, no matter how long the exposure. The closest I have come to making a non-silver print through enlargement was by putting a black-and-white negative in a slide projector about 12 inches from paper sensitized with vandyke solution. After 40 minutes a faint image printed out.

A large negative suitable for contact-printing in non-silver can be made in one step using a pinhole camera of appropriate design.

There is little or no financial barrier to becoming a pinhole photographer. Anything that can be turned into a dark chamber will serve as the body. No lens is needed for a pinhole camera. Instead, a lensless aperture allows light into the camera obscura (dark chamber) to form a latent image on film or enlarging paper.

Pinhole photography demonstrates basic principles of photography such as how the shape of a camera affects the rendition of a subject on film. The relationship of film size to focal length can produce images ranging from extreme wide angle to extreme telephoto. (And then there are all the distortions that can occur when film or enlarging paper is curved, angled, folded or crumpled within the camera.)

The durations of pinhole exposures are usually measured in minutes instead of in the fractions of seconds we are accustomed to with lens cameras. These longer exposures seem like dashes rather than dots in the grid of time and space. When a person poses for minutes at a time, various expressions of the face and subtle movements of the body are conflated onto a single sheet of film. The resulting image may be more akin to a drawing or painting done over time than to a split-second exposure.

Against a dark background a figure can be recorded on film in a number of poses and slow movement can be seen as a blur. Fast movement is invisible except for specular highlights (such as light glinting off metal jewelry) that record as lines. The ultimate specular highlight is the sun, which can be used as a bold drawing instrument by moving the pinhole camera quickly in front of it in a sort of sun dance. The slow paths of the sun across the sky, day after day, can be recorded on extremely slow light-sensitive material, as student Nat Hamilton did a few years ago on paper sensitized with vandyke brown solution in a pinhole camera aimed upwards. Gaps in the paths indicate cloud cover and provide a succinct record of the weather — as long as the pinhole remains unobstructed

by rain, snow, etc. Dominique Stroobant recorded the paths of the sun for as long as 6 months on one piece of film (see *Pinhole Journal* Vol. 4, #2, 1988).

If, during the pinhole exposure of a sunny landscape, a cloud floats in front of the sun, exposure time may have to be prolonged. The combination of highlights gilded by the sun and shadows illuminated by diffuse cloudy light can produce a negative with a sculpted fullness that sun or cloud alone could not reveal.

If no cloud floats in front of the sun, a hand mirror can be used to reflect the sun into areas that need illumination. And indoors, when making pinhole exposures onto panchromatic film that responds to yellow light, a hot light (such as a 500W tungsten or quartz lamp — with 'barn doors' to control the direction of the light) can be moved selectively over the subject. A mirror directing the reflected light of the sun onto parts of the subject outdoors and a hot light moving over the indoor subject are both ways of painting with light.

The soft focus and infinite depth of field in a pinhole negative tend to fuse figure and ground. There is no focal plane but instead a tapestry of tonal values out of which forms emerge. Sometimes it may enhance and even change the meaning of a pinhole image to hold a sheet of cloth behind the subject for at least part of the exposure. (In a print called 'Passage of Time' I held a light gray cloth in front of a bank of blooming flowers for a fraction of the exposure to boost flowers' tonality into a lighter range of values but let withered foreground flowers that were past their prime receive normal exposure and thus print darker. To me this conveyed bright summer followed by autumn.)

How It Works

Pinhole photography may seem a mystery until certain facts are understood. An illuminated object reflects light in all directions, including some light that enters the pinhole aperture. If the subject is a white tulip in a matte black vase, reflected light from the tulip that enters the pinhole will continue traveling in straight lines and will form a latent image on the film that, when developed, will be an almost opaque, dark, upside-down tulip rendition on the film. The matte black vase will not reflect much light and that absence of light will record as mostly clear film in the shape of an upside-down vase at the top of the sheet of film. It follows that light reflected from an illuminated landscape will enter the pinhole from all angles and continue through the tiny aperture in straight lines to expose film or enlarging paper in the camera. An inverted and laterally reversed image will be formed on the film, the same as in a lens camera.

Many people associate pinhole photography with images produced by the traditional cylindrical oatmeal box camera. These are wide-angle renditions that are further distorted by the curvature of the film in the camera so that the subject swells in the middle (where the light has the furthest to travel and the rays of reflected light spread the most) and tapers toward the edges (where it has less distance to travel and spreads the least). But it is just as easy to make a pinhole camera that gives a 'normal' view of the subject like the kind obtained with a 50mm lens on a 35mm camera. For instance, a cardboard carton loaded with flat 8 by l0 inch film (or enlarging paper) that is 12 inches from the pinhole would give such an undistorted view. The 12-inch pinhole-to-film dimension equals the diagonal measurement of the film in the camera. If the focal length were reduced, a view tending towards wide angle would result. An increased focal length would tend towards a telephoto rendition.

Building the Camera

A simple pinhole camera can be fabricated in less than 5 minutes. A very serviceable pinhole camera can be made out of a brown corrugated cardboard carton. If you are planning to expose ordinary black-and-white enlarging paper or an *orthochromatic* sheet film that does not respond to warm brown tones, you don't need to paint the brown carton black inside, or line it with black paper. But if you will be using *panchromatic* film or paper, the interior should be matte black to avoid fogging from reflected brown light.

You will need to tape corners and cracks with opaque tape and fashion a lid (if the carton only has flaps) that generously overlaps the sides of the carton. Some sources recommend black electrical tape, rather than black photographic tape, to make a pinhole camera light-tight. This kind of tape is satisfactory under many conditions of moderate-to-low light, but if the camera is given prolonged exposure to intense light, the film inside it can be fogged by light leaking through the electrical tape. (To demonstrate the difference between the two, look through a dark tube at squares of electrical and photographic tape, side by side on a light table. While no light is visible through the photographic tape, there are so many tiny openings throughout the electrical tape that it looks like a starry night sky. It is worth using the more expensive black photographic tape or else use multiple layers of electrical tape.)

When making a shallow wide-angle camera, use about one square inch of pinhole metal and cut a window in the camera that is just a little smaller. This generous

expanse of metal will allow rays of light entering the camera at oblique angles to travel straight to the film instead of being blocked by the relatively thick edges of your container (which can vignette your image with an amazing magnification of the container's edge). With such a camera, especially if aluminum has been used, it is a good idea to darken the pinhole metal that faces inside to prevent light from bouncing off the film onto the metal's reflective surface and back again, fogging the film. This can be done with black photographic tape, ideally before installation of the pinhole, pressing the tape down carefully and leaving just enough room around the pinhole to admit light from all angles.

Make a shutter for your camera out of black tape with one end folded upon itself to form a tab for easy removal. To keep the pinhole aperture free of stickiness and dust, place a small piece of the black tape face down on the sticky part of the shutter tape where it would actually touch the pinhole. Make sure that the rest of the shutter has enough tack to hold it down around the pinhole. I had the disappointing experience of making pinhole exposures on a mountain in New Mexico and then discovering that a piece of lint had been blocking the aperture. Now I am careful to take a peak through my pinhole to make sure it is unobstructed before each exposure.

Framing the Subject

Light travels in straight lines through the pinhole and onto the film. Therefore, going in the opposite direction, the pinhole photographer can ascertain what will be recorded onto the film by extending lines from the corners of film in the camera through the 'pinhole plane' and out into the subject. (The pinhole plane is the center of the front edge of the camera if the pinhole is in the center of the box.) If the subject is close to a pinhole camera mounted on a tripod, a rod may be laid along sightlines drawn on the top, bottom and sides of the camera and the rod can be extended into the space of the subject, actually touching points on the subject that will indicate the boundaries of the image. When framing a large subject such as a landscape, the photographer can look with one eye along drawn or studded sightlines on the camera to gain an idea of what will be included on the negative.

Image Resolution

With the pinhole camera there is no focal plane, no area in the image on film that appears to be more in focus than a closer or further area. This means that foreground,

middle ground, and background are recorded with equal softness. Bundles of light of varying intensity enter the pinhole and these disks of light, that are known as 'circles of confusion', accumulate to form a latent image on film. The circles begin to turn into ellipses as the angle of entry of bundles of light becomes more acute around the edges of pinhole negatives, especially in wide-angle pinhole cameras.

The size of the circles and ellipses depends on the diameter of the pinhole and the distance between pinhole and film. Rays of reflected light travel in straight lines from the subject through the pinhole and onto the film, but once inside the camera these rays spread so that a long distance from pinhole to film will produce a softer image than a short distance using the same size pinhole.

Fabricating a Pinhole

The word 'pinhole' is really a misnomer since the average pinhole is made using a small sewing needle. Brass shim stock is the metal usually recommended for making pinholes, but it can be hard to obtain. The flat portions of disposable aluminum cookware work as well, the only drawback being that internal reflections from the cooler, bluer aluminum affect blue-sensitive orthochromatic film more than the warmer reflections of brass shim stock. This can be overcome by darkening the inward side of the aluminum as described in the previous section.

Cut a piece of aluminum that is about one inch square with an old pair of scissors (or with a utility blade and straight edge) and lay the metal on a scrap of matboard. Using a thimble or a coin, position the needle perpendicular to the metal and gently push it through the metal onto the scrap of matboard. This initial piercing of the metal will produce a sharp burr on its underside. Sand down the burr with #400 silicone or carborundum paper or crocus cloth or some other fine abrasive. Next push the needle through from the sanded side and sand down the minor burr that results on the unsanded side. Then twirl the square of metal on the needle to make the hole as round as possible.

Hold the metal up against a strong light source to see if it admits one small circle of light. With a loupe or some other magnifying lens, examine the aperture to make sure it is free of debris. To understand how pinhole cameras have such great depth of field, try the following: hold this page of text at a comfortable reading distance; then bring the page so close to your eyes that it is out of focus; now hold the metal with pinhole

against one eye, shut the other eye, and read the page up close. The tiny pinhole is the ultimate 'shut down' aperture that gives maximum depth of field.
You don't have to get too fussy about pinhole size, especially in the beginning. Part of the fun of making a pinhole camera is its low-tech simplicity and latitude. But for those who want optimal pinhole resolution, a table from *Pinhole Photography: Rediscovering a Historic Technique* (3nd Edition, 2004) by Eric Renner and Nancy Spencer (see *Recommended Periodicals & Books* in "Resources") lists on page 162 the optimal pinhole diameters for different 'focal' lengths (the distances between pinhole and film). These optimal diameters produce circles of confusion that overlap by about 30%, an amount that is thought to give the best image definition possible with a pinhole.

It is fairly easy to make pinholes of different diameters with one tapering needle. To make an especially small pinhole aperture, approximately .15mm in diameter, pierce the metal with the tip of the needle from both sides and twirl it right on the tip of the needle. To make a larger pinhole, push the metal square onto the shaft of the needle from both sides and twirl it on the shaft. By using the tapered part of the needle, it is possible to make pinholes in sizes that fall between these extremes.

The diameter of a pinhole can be measured, crudely but effectively, with a millimeter ruler. Place the left edge of the pinhole aperture under a metric ruler so that it bisects the black line marking one of the millimeters. Using a loupe, estimate in tenths how much of the millimeter the pinhole spans. Write the aperture's diameter on the square of metal. The metric system is more convenient in determining the f/stop or speed of your camera.

Calculating your f/stop

Calculate your f/stop by dividing the pinhole diameter into the focal length of your camera. (It is a nuisance to try to divide 9 inches by $^{1}/_{64}$ of an inch compared to doing it quickly on a calculator with metric measurements.) The resulting number, usually in the hundreds, will be the f/stop of your camera with that particular pinhole. If you know the f/stop of your camera you can refer to a table on page 193 in Renner's *Pinhole Photography* (3nd Edition) to get a rough idea of what your exposure time might be with films of various ISOs under various lighting conditions. Renner's 2nd Edition has a more comprehensive chart on page 145 that ranges from noonday sun on sand or snow — to the dim light of dawn or dusk.

Speed of Film or Paper

At UArts, we are sad to have used up a donated supply of Commercial film, a slow black-and-white orthochromatic film (used with a red safelight) with rich continuous tone. Commercial film is still available through Ilford in 8 by 10 inch format for nearly $4 a sheet, but this is a bit steep for students. Less expensive Arista-II Ortho Litho Film (see "Making Enlarged Negatives" for description and also 'Freestyle Photographic Supplies' in 'Resources") works well enough in pinhole cameras rated as ISO 32 and is easy to use with the above-mentioned chart in Renner's 2nd Edition. Enlarging paper is also an option. It is slower, usually rated around ISO 8 but in my experience it is somewhat faster than that. Resin-coated multigrade paper with a pearl or matte surface (less reflective than a glossy surface inside the camera) is a good choice. Since multigrade paper is sensitive to green as well as blue light, foliage is rendered with more detail than with graded paper. (Also, when printing in non-silver processes, exposures through rc paper are shorter than through fiber paper and can be made even more so by pulling the paper base away from the rc image.) It should be mentioned that all of these materials, used inside pinhole cameras, respond very slowly to incandescent light. (Artist Phil Simkin devised a project at the Philadelphia Museum of Art back in the late 70s in which wide-angle pinhole cameras loaded with paper negatives were given to museum visitors to take home and use to record their home spaces. The recommendation for an indoor exposure by incandescent light was for about 20 hours while for an outdoor home space illuminated by direct sunlight it was 15-40 seconds.)

Working by trial and error, you will develop a heightened awareness of the magnitude of light, perhaps even sensitivity to your pupils shutting down or opening up. This approach works best if you stick with one pinhole camera with one aperture. A useable negative should be obtainable in three tries without any charts. There's a lot of latitude with pinhole negatives, especially if you are printing from them in gum bichromate.

There's even more latitude with pinhole negatives now that ordinary people own flatbed scanners. Paper negatives are very easy to scan. Nearly invisible shadow details appear and can be strengthened in Photoshop. Even if you don't have a transparency lid, film negatives backed by white paper can be scanned in the reflective mode. Digital negatives can be produced by a desktop printer (inkjet or laser) or by an imagesetter. See the 'Desktop Negatives' segment in the next chapter, "Enlarged Negatives".

Desktop masks may be prepared to use in conjunction with original pinhole negatives to keep some areas from getting exposure as you print the other parts of the negative.

If you work in layers of color as a painter or printmaker, 'Layers' in Photoshop is suited to a way of thinking that you already grasp. You can produce a number of different digital negatives to print in different colors from a single pinhole negative, and you can view a rough approximation on your monitor of how they would print together.

Developing Pinhole Negatives

Paper developer works well for black-and-white pinhole negatives, both paper and film. It is more active than most film developers and provides the extra highlight density needed for vandyke and palladium.

At home in total darkness I develop panchromatic 8 by 10 inch Tri-X pinhole negatives for 21/2 – 3 minutes, in paper developer. Immersing and agitating each sheet of film in a tray of room temperature water before slipping it into the developer helps prevent developer lap marks, especially in gray areas. After fixing, immersion in a hypoclearing agent will shorten washing time. The refinements of presoak and hypoclearing are not practiced in our non-silver darkroom at UArts, I must confess, and most of the time the negatives are fine, but I found with my own Tri-X pinhole negatives of sky, sand and water that these steps produced better negatives. See "Enlarged Negatives" for more information.

ENLARGED NEGATIVES

Those who photograph with large-format cameras (4 x 5 inches and up) can contact-print directly from their view camera negatives in non-silver. I recommend normal exposure but prolonged development of such negatives to boost highlight density if they are to be printed from in low-contrast vandyke or platinum/palladium. It is possible to make handsome contact prints from medium-format negatives also, as John Joyce has done with $2\,{}^{1}/_{4}$ inch negatives in palladium. But if you want bigger prints from 35mm negatives, or prints that are larger than what you'd get from contact-printing medium or large-format negatives, you will have to make enlarged negatives.

There are many ways to make enlarged negatives: in a chemical darkroom, on a computer and desktop printer, or at a service bureau. A variety of films and papers can be used in both the analog and digital realms. Each procedure and material gives a different rendition of the original negative.

Within the analog realm of the chemical darkroom, choices range from a high-contrast graphic arts interpretation with lith film, to the continuous tone of the few large format films that remain in production, to the fibrous softness of a paper negative. Lith film will be familiar to printmakers who have used it to produce offset lithography plates, photo-etchings, or photo-silkscreens. Negatives rendered on enlarging paper might be familiar to photographers who have used pinhole cameras. Commercial, Copy and Duplicating films may be less familiar and, since they have been widely discontinued, they may remain unfamiliar. In this revision I have omitted discussion of them.

ORTHOLITH FILM

Arista-II Ortho Lith film is currently the most widely available film of this sort (see Freestyle in "Resources"). The unifying feature of all lith films is their graphic, high-contrast response when used with the recommended developers. The term 'lith' encompasses *panchromatic* lith film that is sensitive to all colors (used to make color separations) and *orthochromatic* lith film that is sensitive to blue and green and can be used with a red (1A) safelight.

As is the case with most silver-gelatin films and papers as well as with most non-silver processes, lith film is *negative-acting*. Therefore, when you project a small format negative onto a sheet of lith film, a positive transparency will result just as would have happened if you had put enlarging paper in the easel instead of lith film. This positive image on film is called the *interpositive*. If you were exposing a photo-silkscreen,

photo-etching, or positive litho plate, you could stop your silver darkroom work after producing the positive, but with negative-acting non-silver processes, it is then necessary to make a negative from this interpositive.

The enlarged *negative* is obtained by projecting or contact-printing the interpositive onto a second sheet of film. For instance, you could enlarge from a 35mm negative onto a 4″ x 5″ interpositive which could then be projected in a 4″ x 5″ enlarger onto a piece of 11″ x 14″ film. To really save film, you could contact-print an entire sheet of 35mm negatives onto lith film as if you were making a traditional contact sheet on enlarging paper; you could then cut the positives into strips and project from single frames like 35mm negatives onto sheets of lith film. This would create a very broad effect with huge grain on your enlarged negative. Any speck of dust on the 35mm negative or positive would be greatly magnified on the enlarged negative. It *is* possible to spot such open areas with *Pitt Pens* or something else that blocks actinic light. It is also possible to scrape away silver where it is not wanted with a scalpel or abrade it with sandpaper or steel wool. But an enlarged negative with the finest detail and tonal nuance is made from a full-size positive that is contact-printed to get the enlarged negative. And with lith film, a flat, tonal interpositive can yield a more detailed enlarged negative.

Ortholith film comes pre-cut in many sizes. Unlike most sheet films, it is not code notched. The emulsion side is dull and pinkish; the base side is glossy and red with anti-halation dye which prevents light from passing through the film and reflecting slots and scratches on your easel onto your film from the back. All lith film (orthochromatic and panchromatic) must be handled with more care than photographic paper or other films since fingerprints show up very easily. Plan to make enlarged positives and negatives with half-inch margins and touch only the edges of the film. During tray processing, do not use tongs, which usually scratch or contaminate the film. Instead wear sheer disposable gloves on both hands, hold the film by the edges, and drain the developer off of it by tilting the film back and forth from one corner to another to avoid streaking. Areas that were solid mid-tones in the original negative are especially prone to streaking.

To obtain a contrasty positive (on the way to getting an even more contrasty enlarged negative), develop your lith film in Kodalith developer or its equivalent. Make a careful test strip before exposing and developing an entire sheet of film. The duration of your exposure *and* development will determine the dividing line between opaque black and clear film base in your lith transparency. You can make a number of different enlarged negatives, via inter-positives, from the same small format negative by varying exposure

and/or development times. The split between clear and opaque film will fall at different densities, like a topographical map. You can then print a different gum bichromate color, for instance, from each negative, one on top of the other. The result will be a posterized image (think Andy Warhol but less graphic with transparent gum colors).

Dot Pattern

To obtain a fine random dot rendition of a camera negative, project it through a sheet of ground or non-glare glass that is lying, rough side down, on top of lith film, and develop the film in the recommended developer. This method relies on the ground or subtly etched glass to bend light and fragment the image into very fine random dots.

Another kind of dot pattern, no longer random, can be obtained with a traditional dot screen (halftone) that is in tight contact with lith film either under an enlarger or in a copy camera. Before the digital revolution this method provided the high-contrast transparencies used in offset lithography. A halftone screen was expensive and easily scratched. It consists of tiny continuous-tone openings in a grid. Light projected through or reflected from an image penetrates the continuous-tone parts of the screen in varying amounts. Upon development, solid silver shapes of varying size within the grid form either a positive from a negative or a negative from a positive.

These ways of generating images *suggest* continuous tone while meeting the full-ink or no-ink requirements of offset lithography and screen-printing.

Continuous Tone on Lith Film

Unlike screen-printing and offset lithography, non-silver processes can render fine gradations of tone as *varying* amounts of actinic light penetrate different parts of a continuous-tone negative. As mentioned earlier, a halftone or even a random dot is not necessary unless you specifically want the look of it. Many non-silver artists work with view cameras or big pinhole cameras and contact print their large-format continuous-tone negatives directly against coated paper.

Although lith film is designed to be used with a high-contrast graphic arts developer, many non-silver workers use lith film in view cameras, pinhole cameras, copy cameras and under enlargers. They develop both positives and negatives in diluted paper developer (Dektol or any other normal paper developer) to get partially

continuous-tone lith negatives. Shadows still fill in and highlights block up, but in the midtones (between about Zones III and VII) there is continuous tone. Exactly where that range of continuous tone falls depends on exposure and development time — so again, you should make careful test strips. I must add here that ortholith film should be watched carefully under the red safelight during development. You should be ready with two gloved hands to yank it from the developer at just the right moment, and quickly slip it into the stop bath. For continuous-tone films it is much harder to judge development by inspection. With them flexibility should be in exposure time and a set development time should be adhered to. But lith film has none of the confusing chemical fogging of shadow areas that makes it hard to judge continuous-tone films during development under a red safelight.

There is no recommended dilution of paper developer to use with lith film because so much depends on the nature of the original negative, water temperature, status of developer and the desired results. Some of you will find that normal strength paper developer suffices with a minimal exposure onto the lith film. Others will dilute the paper developer with 10 times its volume in water or even more to get a satisfactory negative. Unfortunately Kodak's Selectol-Soft developer (or the equivalent) that got maximum highlight separation and shadow detail out of lith film is no longer available.

Photograms

You may have made photograms already by laying objects on paper sensitized with non-silver chemicals. The result was light shapes on a dark ground. If you would like to have dark shapes on a light ground, try placing or contacting objects on a sheet of lith film under an enlarger light or another light source. If some of the objects are semi-transparent, make test strips to find out which exposure gives the desired rendering of intermediate tones. Try different developers for a variety of interpretations. The resulting photogram negative can then be contact-printed against a non-silver process to obtain a positive photogram print. Obviously this kind of photogram is more repeatable than an array of objects placed directly upon sensitized paper.

Contact Prints

At the beginning of the introductory course in non-silver, in an effort to bridge the gap between the hand and the camera, I ask each student to make a tonal drawing or painting on a translucent material such as tracing paper or frosted mylar. Some of the

students, realizing that values will be reversed when they contact print against paper sensitized with cyanotype or vandyke, manage to draw negatives. Others work abstractly or accept the inverted values. For those who produce positive drawings or paintings that should be rendered as positives for full effect, there is the option of contact printing their work against lith film to get high fidelity negatives. This can be done under a calibrated light source such as an enlarger (without anything in the negative carrier) where careful test strips will determine exposure times. The original must be snugly contacted against the film under glass, in a contact frame of some sort, even if it is a simple arrangementsof masonite, foam and plate glass. The glass must be free of scratches and dust, which show up clearly on sensitive lith film. (This is not the case when printing in non-silver where the powerful actinic light burns through such minor obstructions.) Different developers may be used for a variety of interpretations.

Wildly Varying Exposure Times (film-base-plus-fog density)

An easy test of a film's sensitivity to safelight is to lay a coin on a piece of film for the amount of time it might be under the safelight while being exposed and then develop it. If you see the coin shape as a clear disk on a gray background you know that your film is being fogged in the darkroom. Students tend not to recognize such fogging on their negatives when they look at them on a light table because the image is still visible and then they are mystified when their image barely prints in non-silver. A simple way of perceiving fogging is to lay the dry developed negative on a piece of printed matter in normal light. You should be able to read the text through the open parts of the negative.

Test to see if a film has been accidentally fogged by other means by transferring a piece of film straight from the film/paper safe into paper developer, process, and see if it looks fogged overall or in certain areas. Very old film fogs around the edges.

Expensive continuous-tone film has a fairly thick mylar support, the film base, that holds back some light. In addition there is a certain amount of unavoidable 'chemical fogging', a veil of metallic silver that is deposited on most continuous-tone films (but not on lith film). These two factors plus fogging from causes mentioned above (and others) help to explain why a single exposure time under a specific light source for all negatives onto a particular non-silver process cannot be prescribed.

If you couldn't avoid fogging and it is reducing contrast and extending exposure time significantly, you can easily prepare a homemade version of the proprietary 'Farmer's

Reducer' to remove some of it. Set up two trays of water, one with a perfectly flat bottom. Sprinkle potassium ferricyanide, maybe a teaspoon per quart or liter, into the flat tray and agitate until the water is yellow and there are no red grains that haven't dissolved. Add a few ounces of liquid fixer concentrate to the same tray. The potassium ferricyanide (acting here as a silver bleach) will convert a thin layer of metallic silver back into transparent silver salts and the fixer will remove the silver salts so they don't turn metallic and opaque again when exposed to light. The second tray of water is for you to flip and briefly wash the negative in before you lift it out and hold it against a light to see if the fogging is reduced. (Otherwise, droplets of the potassium ferricyanide will continue to act on the film as you are studying it, creating a blotchy effect.) If you are reducing fog on a number of negatives, you will need to replenish the potassium ferricyanide as it loses potency and its yellow color but the fixer may not need to be replenished. The potassium ferricyanide weakens over time, as well as use, so replenish every half hour regardless of use. Many a fogged or over-exposed negative has been rendered useable by this free-wheeling procedure.

From Small-Format Negative to Interpositive to Enlarged Negative

Regarding contrast, you can compensate for deficiencies in your small-format negative as you first project it to obtain the interpositive and then again project the interpositive, or contact print it, to obtain the requisite large negative. It makes sense to burn and dodge as needed on the interpositive as you would on enlarging paper.

When you are enlarging an interpositive film from a very contrasty small negative (that would require grade 1 or 0 enlarging paper or the corresponding filter with multigrade enlarging paper), a film developer would work well. For a normal rendition of a normal negative that you would enlarge onto grade 2 or 3 paper, paper developers, which are more active than film developers and give denser highlights, work well. If the projected negative is thin it is OK to make a rather flat interpositive using normal dilution paper developer (or only somewhat diluted) but when you make the enlarged negative you can boost contrast without losing detail by using a more normal or even more concentrated paper developer and, if necessary, extending development time.

Copy Camera

A *copy camera* allows you to obtain in one step an enlarged, reduced, or same-size negative of whatever you put on the copy stand. A copy camera is essentially a large

view camera, either vertical or horizontal, that can provide a negative, on the film or enlarging paper of your choice, of anything placed within the coverage of its lens. You can make a large negative in one step by exposing a finished photographic print onto sheet film. The advantage of exposing a finished print onto film (in addition to the time and film it saves since an interpositive does not have to be made) is that dodging, burning, bleaching and spotting can be accomplished ahead of time on the finished print. A disadvantage is that reflected light from a print does not contain as much tonal information as light transmitted through a positive transparency so a copy camera negative may not have the range of densities of a negative made with a film interpositive.

Flat work other than photographs, such as drawings, paintings and collages, may be translated into negatives in a copy camera too.

Three-dimensional forms can be photographed onto negative film with a copy camera. It has become a rite of passage for non-silver students to endure the blinding light and prolonged pose necessary to have large-format portrait negatives of themselves made on the copy camera at school. The lens is usually shut down for greater depth of field and exposure times are increased correspondingly. The resulting images have an uncanny presence and sense of volume. See the chapter on "Instructions for Copy Cameras", for more information about using copy cameras.

DUPLICATING FILM — This kind of film is described for those who may have some in stock. At UArts we still have a good supply of free high-contrast duplicating film donated to us by the American College of Radiology when they went digital.

With duplicating film it is possible to obtain a continuous-tone negative directly from an original negative in one step. It works best when making a contact copy of a large- format negative in an ultraviolet exposure unit designed for that purpose which was also donated to us. It is great for duplicating precious view camera negatives and glass plate negatives as well as for making denser or thinner contact negatives. Fixed negatives of varying densities of flat photogram materials can be made too.

It is *interesting* to know about the far side of the characteristic curve and helps in understanding the phenomenon of solarization. This film has been pre-exposed by the manufacturer to the point where it is on the top, the shoulder, of its characteristic curve. Additional exposure will send it down the seldom represented far side of its curve, opening up the film instead of darkening it. This is basically what solarization is.

(Sometimes a brief exposure of the orb of the sun in a pinhole camera will look on the film like a dark halo that is clear in the center where it got the most intense exposure and I imagine that the term 'solarize' comes from observation of this phenomenon.) You will know you haven't given the duplicating film enough exposure if it comes out too dense.

Like ortholith film, duplicating film is orthochromatic but less light sensitive. The same red safelight (1A) is recommended for it but even amber light is useable since the emulsion is so slow. Unlike lith film, some duplicating film does not have a red dye anti-halation backing. It can be exposed through either side, but it is useful to be consistent about which side of the duplicating film (referring to notch position) you expose onto when making the enlarged negative since exposure times can slightly different from one side to the other. You may need to mark or notch your test strips to know which side is which — once the corner with the manufacturer's notch has been removed.

Develop duplicating film in full strength or extra concentrated paper developer to maximize contrast. Lack of contrast is common with this film. Our supply of duplicating film is quite old and the paper developer needs to be very concentrated like 1:3. Farmer's Reducer equivalent may be useful later to remove any fogging on the negative.

PAPER NEGATIVES from the Chemical Darkroom — Black-and-white photographic paper can be used in various ways to make large negatives. With prices for sheet film as high as they are (and the discontinuance of many of them), paper seems an increasingly attractive alternative. The paper negative prints in non-silver with a broad, sculptural, fibrous look reminiscent of the beginnings of photography.

It usually takes longer to expose material sensitized with non-silver chemistry through a paper negative than through a film negative because the fiber of the paper blocks much of the actinic light (although sometimes a film negative has so much fogging that *it* takes longer). When using the sun as a light source, the fibrous density of a paper negative is not much of a drawback. For instance, a cyanotype that takes 5 minutes to expose with a normal film negative might take 10 or 15 minutes with a resin-coated paper negative. A way to shorten exposure time with resin-coated paper is to separate the plastic emulsion layer from the paper base by carefully peeling the layers apart. Some workers have found that soaking the print in warm water facilitates this separation. The resulting, often uneven, plastic emulsion layer with residual paper fiber attached to it sometimes curls and can be hard to handle but, as printmaking major Mortimer Hechavarria discovered, the curl can be straightened by folding clear

or frosted tape along the four edges of the emulsion layer. Sometimes the rough look of residual paper fiber adds charm to the non-silver print.

Registration of a paper negative on top of a multi-layered non-silver print is somewhat more difficult than with a film negative but it can be done by eye on a light- table if a dark color is printed first. The non-silver print should be taped down, the negative placed face down on top, and a tube of black paper used to block out all light except what is coming up through the sandwich of positive print and negative. The tube can be moved about to make certain that already-printed areas lie within the open parts of the negative. You may, however, need to use some other kind of registration such as marking the printing paper with pencils at the corners of the paper negative after you print your first layer. With a straight-edge you can extend these marks into the print margins (in case the second layer of emulsion covers and obscures the actual corners of the film).

A paper negative can be made on the copy camera with enlarging paper in the same manner as a film negative, with flat or three-dimensional material as subject matter. The exposure for creating a paper negative may need to be 2 stops more than for lith film.

Enlarging paper works well in pinhole cameras providing negatives that print especially well in gum. In oatmeal-box cameras and very shallow pinhole cameras, use paper with matte, pearl or luster surfaces to prevent the internal reflections (sometimes baffling and ghostly) that can occur with glossy paper. Multigrade paper is sensitive to green light, as well as blue, so that it renders foliage better than graded paper. Resin-coated paper works nicely. Double-weight fiber paper is too dense to print through. There used to be a single-ply fiber enlarging paper by Kodak called Polyfiber-A that was perfect for pinhole negatives. It had a fibrous, tactile quality and lent itself to tearing, cutting and collaging. I have tried other single-ply fiber papers that I've come across and have not been as happy with them. They all seem to have a clay coating that makes it hard for actinic light to penetrate the paper negative and form an image in non-silver.

You can draw or paint on paper negatives to strengthen highlights, eliminate shadows or otherwise modify the image. Turn the paper negative emulsion side down on a light table and work on the back of the sheet (assuming that the back of the print is fibrous and not a slick resin). Red or orange pencils and washes are especially effective in holding back actinic light. (Film can be scratched open on the emulsion side and painted on either side but is too slick on the back to draw upon with normal pencils.)

IMAGESETTER NEGATIVES

Digital halftones with very smooth tonal gradations can be produced by a Scitex imagesetter that was donated to the I-Lab at UArts. A high-contrast lith film is exposed by very fine laser beams and developed in a mechanical processor with darkroom chemicals to produce a digital halftone negative. The halftone grid of 200 lines per inch (each line being a 4 x 4 dot grid) is scarcely visible when you make prints from these negatives in cyanotype, vandyke or palladium, and is invisible with duotone renditions of those processes or multiple layers of gum emulsion. Other imagesetters (including Scitex), located at service bureaus, can print very fine random dot images with a resolution of 2400 dots per inch or higher, close to or surpassing the grain pattern of silver on film. Unfortunately, nowadays most offset litho plates for which the imagesetter was developed are photo-sensitized and are exposed directly by the laser beams so the imagesetter is going extinct.

DESKTOP NEGATIVES – Being able to make digital negatives at home or in a computer lab at school, instead of having to go to a service bureau, is a goal of many non-silver printers. Dan Burkholder's book, *Making Digital Negatives for Contact Printing* (see "Resources") has advice on making desktop negatives that has influenced many of us. Included in this edition are descriptions by Sandra C. Davis and by Melissa Good of how they make desktop negatives.

Desktop negatives can be produced in inkjet on Pictorico or Inkpress transparency film and used with non-silver with curve adjustments made for different processes (see 'Curves' by Sandra Davis). With varying results inkjet negatives can be printed on vellum or even inexpensive computer paper. This works best with gum printing. Also an inkjet positive can be enlarged into a negative on lith film on the copy camera.

Photo senior Alex Miller found someone at Staples who produced flawless unbanded laser negatives for him from enlarged scans of insects that printed remarkably well in palladium. Other students have printed successfully in gum from less perfect laser cmyk negatives. The multiple layers made the banding less obvious.

The future of non-silver processes is probably inextricably linked with the production of inkjet and laser negatives.

DESKTOP NEGATIVES by **Sandra C. Davis**

A series of experiments I made after taking a workshop with Dan Burkholder, author of *Making Digital Negatives for Contact Printing**

I begin by scanning my 35mm or 120 black and white negatives into the computer using a Nikon Super Coolscan 8000 scanner. This scans film only by pulling the film into the scanner and pushing it back out when it is done. I then manipulate the images in Adobe Photoshop on a Macintosh G5 computer. Most of the manipulation consists of various ways of burning and dodging areas of the image, as I would normally do in the darkroom, if I were printing regular 'silver' black-and-white prints.

The final output is on a transparency film made by Pictorico, (available at www.Pictorico.com), which has a thin clay coating on the surface that holds the ink-pigment. The negatives are printed in 'color' from an image that appears black and white in Photoshop, using an Epson stylus Photo 2200 printer. This printer was designed to print using a pigment base 'ink' rather than the standard dye base ink. Epson claims their pigment color is "fade proof" for 200 years. I use it, because the pigment dries quickly with no streaking or puddling.

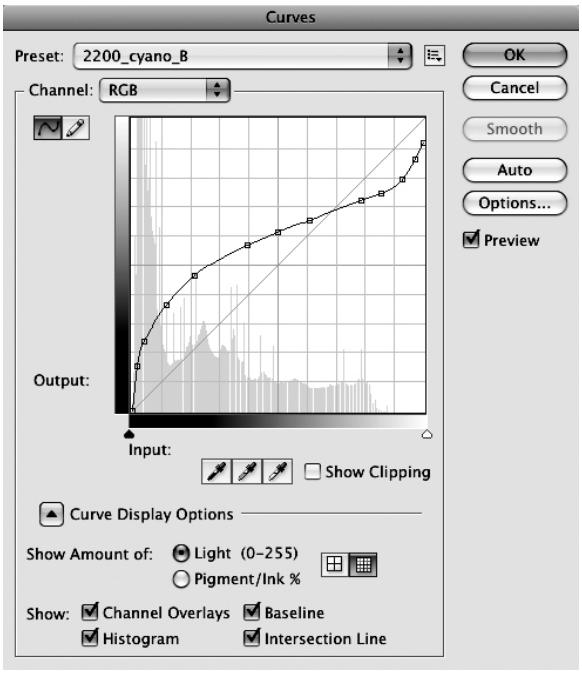
The process of making 'desktop negatives' is different from making negatives in Photoshop and sending them to an imagesetter. There is a series of contrast curves that must be applied to make the printer actually print the image as it appears on screen. When the image looks great on screen the last three steps before sending it to print are: 1) Turn the image into an RGB file. 2) Put a contrast curve on it as an adjustment layer, which makes it appear 'wrong', (it makes most of the image appear 'blown out'). 3) Turn it into a negative by putting an 'invert adjustment layer' on as the top layer. These contrast curves are the genius of Dan Burkholder who designed most of the curves for printing platinum from desktop negatives. The goal is to place a step tablet on each image and make this print with accurate percentages of 5% on up through 100% in the non-silver process, i.e. cyanotype, palladium, or vandyke. After the print is made from the negative in one of the non-silver processes, it is evaluated for accuracy of the step tablet. Once this is achieved, all images with this contrast curve added should print accurately. Note that each process has a different contrast, so one curve has to be 'designed' for palladium and a different curve must be 'designed' for cyanotype. I have found that the same curve can be used to print a negative that can work for palladium as well as gum bichromate. In Photoshop, curves can be applied on separate layers and saved as 'curve presets' to be reused on future images.

The other issue of printing from computers is the sharpness of an image. Images can be over-sharpened and appear 'pixilated'. Photoshop has a filter called "Unsharp Mask" with an infinite number of options for sharpening. I found that using grainy film wreaks havoc on the image if over-sharpened. Sharpening works by Photoshop "looking for a difference in tone" and increasing the difference. At the risk of sounding technical, I'll just say that over-sharpening can make Photoshop 'draw' a white circle around each spot of grain.

With curves and sharpening 'conquered', I have made successful images from "Desktop Negatives".

Below are the contrast curves I created which I applied to the final image just before sending it to the printer. Note: each vertical line in the grid represents10% with the left edge being 100% and the right edge being 0%. Different inkjet printers will print negatives differently. This new curve for my Epson Stylus 2200 is different than the one Dan Burkholder created when he tested an Epson 2200. Also I discovered that the contrast curve works differently if applied to an RGB image than when applied to a grayscale image. You will have to create your own curves for your images. These and the Curves included in Dan's book are just a starting point. Enjoy!

*Making Digital Negatives for Contact Printing Second Edition by Dan Burkholder is published by Bladed Iris Press ISBN#0-9649638-6-8 It includes a CD with step tablets and 'starting point' curves.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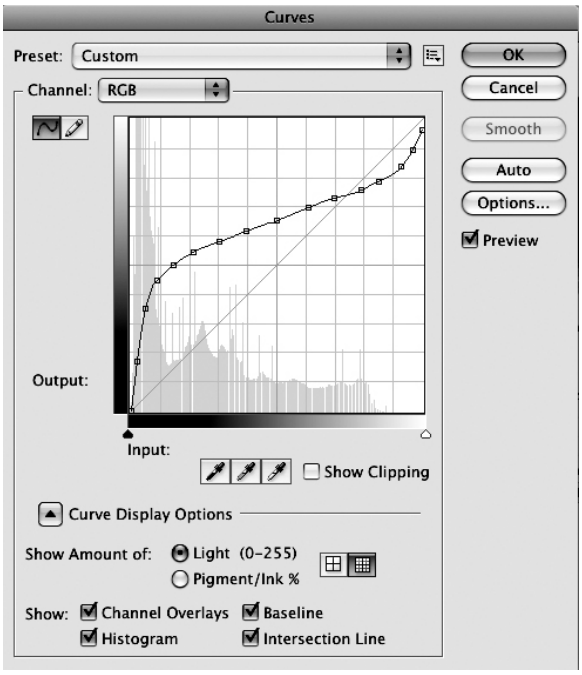
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INSTRUCTIONS FOR COPY CAMERAS

by **SVK, Sandra C. Davis, & Stuart Goldstein**

A copy camera is essentially a large view camera in a fixed horizontal or vertical position. Historically it has been used to produce negatives to contact print onto offset lithography plates. Continuous-tone images were broken down into dot patterns with halftone screens to satisfy the full ink/no ink requirement of that means of printing. Those of us who work in non-silver who play with such a dinosaur use it as view camera, enlarger and scanner. In our new facility at UArts we inherited a horizontal Brown copy camera that is about 16 feet long with the film end in a small silver darkroom. No charts or manual came with the camera so we are feeling our way regarding f/stops and exposure times for lith film in various enlargements or reductions. So far we've had wonderful results, especially with life-size portraits that have a strong presence.

CHEMICALS TO PROCESS YOUR FILM

Before you expose your film, check the sink in the little silver darkroom to make sure that the chemicals you need to process it have been mixed.

If the chemicals aren't mixed during class time, you can either ask the T.A. or teacher to do this for you or you could mix the chemicals yourself. (Directions are taped to the shelf on which the chemical containers rest). If you mix fresh chemicals, note the time and date that you mixed them on the sheet that's to the left of the chemical trays.

If the chemicals are already mixed and in the trays, check the sheet on the wall to see when they were mixed. If it was over 3 hours ago, test the chemicals as described below.

TESTING TO SEE IF THE CHEMICALS ARE STILL GOOD

Testing the Developer and Stop Bath

Turn on the exhaust fan and remove tray lids. If the developer is brown, you should discard it and mix a fresh tray of developer. If it is yellowish-tan it is worth testing. If Sprint stop bath has turned purple it is expired and should be discarded. Other stop baths may not have such an indicator.

Under the red safelights, take a scrap of film from the batch you are using, close the film box, and expose the scrap for a few seconds to white light. Agitate it in the paper developer for 1-2 minutes wearing sheer disposable gloves. Then agitate the film in the stop bath for 30 seconds and, through the gloves, feel if it is as slippery as it felt when

you removed it from the developer, or if it now feels squeaky-clean. Skip the fixer (since there is no unexposed silver to remove) and rinse the scrap in the wash tray. Holding it over a drip tray, take the film out of the wash and position it between yourself and a white light source. The film should be fairly opaque. If looking through it is like looking through sunglasses, the developer is old and it needs to be replenished or replaced. You can replenish it with two to four ounces of print developer concentrate. If the film felt slippery after its immersion in the stop bath, the stop bath may need replenishment also.

Testing the Fixer

If the fixer smells sulfurous or looks murky, recycle the fixer by pouring it into a white silver recovery unit at the right end of the sink and mix a fresh batch. Otherwise, under the red safelights, again take a scrap of unexposed film from your film source. Make sure the film box is closed, and then turn on the white light. Slip the film directly into the fixer. You have fogged the scrap of film but, because you have not developed it, the silver salts have not turned into metallic silver and can still be dissolved out in fixer. Leave the film in the fixer for a minute. If the film has not completely cleared in that time period, the fixer may need to be replenished with 3 or 4 ounces of fixer concentrate.

REPRODUCTION PERCENTAGES

If you wish to have a negative the same size as your original copy material, you will be copying it at 100% and will set both the copy stand and the length of the bellows at 100%. If you wish to reduce or enlarge the negative, the percentage of reduction or enlargement must be determined. To do this, you measure the longer side of thematerial you want to copy and decide how long you want to make it on the negative. For instance, if the longer side of the image is 5" and you want the longer side of the negative to be 7", you'll need to know at what percentage to set copy and lens to accomplish this enlargement. A pair of rotating disks that should be tacked to the wall in the silver darkroom, called a proportional scale, will conveniently calculate the percentage. You will notice that there's an inner circle of inches and an outer circle of inches. The inner circle indicates the length of the original (5 inches) and the outer circle the length of the negative (7 inches). Align the inner and outer numbers so that the original's length is directly under the length intended for the negative. Your reproduction percentage (140%) appears in a window on the scale with an arrow pointing at it.

PREPARING THE COPY CAMERA

Glass

Dust and streaks and scratches on the plate glass that covers the copy will show up on your negative. With the room lights on, clean the glass—on both sides if necessary—with glass spray applied to paper towels. Doing this in the beginning will save time, film and aggravation.

Now place your dust free-image under the glass in the center of the copy area. If you want to use a paper grayscale, place it under the glass as well.

Lights

Take a look at the quartz lights on the copy camera before turning on 'power'. For flat copy work, the 4 lamps should be at 45° angles to the copy. Use the protractor-like angle measurements to confirm the angles, carefully loosening and tightening the controls. By eye evenly space the 4 lamps above and below the copy, again loosening and tightening controls, never forcing.

If you want to backlight translucent copy, remove the black foam 'target' from the copy camera's board and replace it with translucent copy and a film grayscale if desired. Loosen and swing the 4 lights so they are behind the copy at 45% angles above and below the copy.

POSITIONING COPY AND LENS

Copy and Lens Percentages Agree

Set both the copy board and the lens positions to the percentage that you calculated. Unfortunately it is no longer possible to do this from within the silver darkroom. Instead you will need to do it manually by releasing the lock on the bellows, moving it so that a marker is aligned below with the desired enlargement, 140% in this case, and locking it in place. Do the same for the copy, setting it for 140% also. Never force movement with the camera. Always search for ways to unloosen and tighten controls.

When making copy camera negatives of people or other 3D matter, compensate for the depth of the subject by moving back the copy board so that the part of the subject you desire to have in focus is where the copy board was. Have your subject lean her head against the board for stability. A cloth can be draped over the board as a backdrop. To gain more depth of field shut down the lens, doubling exposure time for every f/stop.

Fine Tune Focus with Loupe

To fine tune your focus, open the vacuum back away from the camera in the silver darkroom, gently lower the frosted focusing glass and place a loupe or some other magnifier on the glass. Turn on the quartz lights and see if the subject is in focus. If not move the copy board or the 3-D subject forward or backward until it is in focus, remembering to lock and unlock the bellows or copy board.

If you want to move the subject's image slightly up and down or side-to-side you can push the red buttons like channel or volume controls on a remote. You can note where the image falls on the ground glass and place white artist tape on the corresponding measurements on the vacuum back so you know where to place your film.

MAKING YOUR EXPOSURE

Now that you've focused your image, you have to close down the lens for the proper exposure. For flat copy f/11 is a good choice. For 3D copy a smaller f/stop would be better. Recommended exposure times for various f/stops are in the process of being determined but are in a range from maybe 15 seconds to 2 minutes. Results of experimentation will be posted as they are arrived at.

With the door to the silver darkroom closed and only the red safelights on, take out a test strip of the film you will be using and make a test exposure by turning on the vacuum motor and placing the film with the dark glossy side against the vacuum and the dull light emulsion side positioned to receive the exposure when you raise the frosted glass and close the vacuum door.

Make sure you have put away any film that you're not using for this exposure (otherwise it will be ruined). Now you're ready.

Shout 'LIGHTS!' and press the start button. The exposure lights will go on and the copy camera should automatically turn off the lights at the end of the time you set, but count seconds to make sure it is cutting off when it should. Grab an edge of the film and step on the vacuum pedal to turn off the vacuum.

PROCESSING YOUR FILM

Set the darkroom clock for 2 minutes and quickly slip your film, emulsion side up, into the developer. Rock the tray to cover the surface of the film with developer immediately. If only part of the film is covered in the first few seconds there will be a pronounced 'lap mark' around the area that didn't get covered.

Properly exposed lith film should take between 1 and 2 minutes to develop in diluted paper developer. After the first minute watch the film carefully and be poised to take it out The film can go too dark very quickly and will continue to darken while draining. It is important to drain this film by two corners so that the developer curtains evenly and doesn't leave streaks, especially in gray areas. Use lith developer for the highest contrast. Print developer in its normal dilution gives high contrast with a bit more gradation between clear and opaque. To approximate continuous tone, dilute paper developer (1:27 or so, instead of 1:9).

Agitate film in the stop bath for 30 seconds and fix for 2 minutes (or for twice the time it takes the film to clear).

Wash the film briefly while you clean the .wet light table by the copy camera. Place a drip tray under the negative and on the light table check the negative for any problems.

Once you've checked your negative, no matter how bad it is, put it back in the wash (make sure the tray siphon is operating) for about 5 minutes with the temperature between 70 and 80 degrees Fahrenheit. The closer to 80˚ the water is, the faster fixer washes off the film but the tenderer the emulsion becomes. Don't let it get scratched by the corners of other negatives or by your fingernails. It is a good idea to finish washing the negative by spraying it with water at a 45 degree angle to remove any gritty sediment from the Philadelphia water. Hang your negative to drip on the line above the sink. Never throw away film. You or somebody else might intensify or reduce it, and scratch or paint or collage it to create a new unimagined work of art. Also, it helps your teacher understand what is causing a problem to see the failed negative instead of hearing that you threw it in the trash…

If you are in a hurry you can dry your film in the film drying locker. Please be sure to turn it off immediately after use since it could overheat (and consumes a lot of power). Don't lay lith film on drying racks since it may pick up contamination and the imprint of the screening. Don't let sheets of film dry touching each other. The emulsion is sticky and will rip off if it dries against another sheet of film.

Consider yourself lucky to be able to use the copy camera and the orthochromatic silver darkroom — with the safelights off it is also the only remaining panchromatic darkroom at UArts for tray processing. With the I-lab and a computer lab on the same floor we have the old and the new, the analog and the digital in fertile proximity so that students can experience both modalities and compare results.

Over the years I have seen many stunning vandyke brown prints by undergraduate and graduate students working in non-silver. Sometimes a fortuitous coupling of light-resist and process occurred. Other times the student cared and learned enough to craft a negative that would bring out what the process has to offer.

This process can render an image in rich browns that record every nuance of density within a light-resist. But it can also deliver a flat gray-brown print, mottled and disappointing, when used with a low contrast negative (or even a 'normal' negative) and/or improperly handled.

Characteristics

Printed with the appropriate negative, vandyke has the tonal range of platinum or palladium. All three of these processes have, within their characteristic curves (a succinct visualization of the amount of printing-out of a process per unit of exposure), extensive straight-line segments along which there is reciprocity of response in image tone to unit of light. A self-masking characteristic of vandyke (along with platinum and palladium) allows a long exposure of dense highlights without the loss of shadow detail that occurs with silver prints. Such a true positive from a negative is possible because vandyke prints out somewhat during exposure instead of only during development: shadow areas turn a reddish brown which acts locally as a filter or mask to prevent further exposure. Although cyanotypes also print out (much more, actually) during exposure, the purple-blue-gray-green colors they turn do not hold back actinic light and shadows do block up. Vandyke, palladium, and platinum are self-masking; cyanotype is not.

Although much of the vandyke image is formed of silver, this process is in the iron print category along with cyanotype, platinum and palladium. In all of these processes, iron salt in a ferric state is reduced where it is struck by actinic light to become ferrous. In a vandyke brown print, silver nitrate lying in contact with the newly ferrous iron is reduced to visible metal during development in a weak fixer. Unexposed iron salts cannot be etched away, as they can be in platinum and palladium, because an acid etch would destroy the silver image. (Only the so-called 'noble' metals such as gold, platinum and palladium are relatively insoluble in acid.) Over time, residual iron salts that weren't washed out may reduce, giving off-white tones to the highlights of the print. (It is possible that EDTA salts in water could work as chelating agents to remove residual iron salts, but preliminary tests by photographer John Woodin and myself have not confirmed this.) Over the years the vandyke brown process has been referred to as 'the poor man's platinum print' because of its beautiful long tonal scale, but it has also

suffered from concerns about its stability over time. It would be wonderful if someone somewhere would test the stability of vandyke on a range of papers with a range of clearing agents in a more rigorous manner than we have had the time to do. It has to be someone who is in love with the look of the process who wants to make sure that image highlights do not darken and that the silver forming the rich brown image remains a rich brown. I could imagine being such a person if I weren't already committed to doing my own work in cyanotype and gum bichromate…

Paper and Cloth Supports

Arches Platine, Arches Cover, Bergger Cot320 (available from Bostick & Sullivan), and Strathmore single-ply series 500 papers (both hot and cold press) print with higher contrast and clearer highlights than a soft paper like BFK Rives which absorbs the vandyke solution and doesn't easily release it. But plenty of good vandykes have been made on BFK and on many other kinds of paper. Impurities in some papers react with vandyke solution to produce unwanted spots or streaks, sometimes light and sometimes dark. With vandyke we are even somewhat restricted with paper size since our designated processing trays are approximately 13″ x 16″; however, larger trays that have been used for cyanotype or gum may be used if they are swabbed out and rinsed thoroughly.

Vandyke prints richly on natural fibers like cotton, silk, rayon and linen. Unfortunately, in our non-silver darkroom we have no place to safely hang large pieces of cloth sensitized with vandyke brown solution. The silver nitrate in the solution is too burning to the skin and blinding to the eyes to take any chances with someone who might come into accidental contact with wet sensitized cloth hanging in the darkroom. *It* is possible in our darkroom to print on cloth smaller than 13″ by 16″ that can be taped to pieces of glass or plexi before applying vandyke solution and then slid into the drying rack and dried on that surface. A certain amount of the solution will soak through the cloth onto the glass or plexi and should be cleaned off thoroughly when the cloth is removed since next person who needs to use the surface may not recognize vandyke solution on the surface and could be hurt.

Safety

Before reaching for the single bottle of vandyke chemistry, *put on gloves!* If traces of silver nitrate are on the bottle, your bare fingers will be stained and burned. If you should get it on your skin, wash the afflicted area with cool water. Protect your eyes by wearing glasses instead of contact lenses. Consider using goggles or a face shield if you

don't wear glasses — at least until you feel confident applying the vandyke solution. If any solution ends up in your eye, use the emergency eyewash station or flood the afflicted eye with water and seek medical attention. Clean up all surfaces. An invisible film of silver nitrate left on the coating table could hurt someone else.

Mixing the Chemicals

The formula for making one quart of vandyke brown solution is:

29 grams (≈ l ounce) silver nitrate
90 grams (≈ 3 ounces) ferric ammonium citrate
15 grams (≈ 1/2 ounce) tartaric acid

Pour each of the three chemicals into 3 separate labeled containers (used only for this purpose), each containing 8 ounces (236 ml) of *distilled* water. (It is more important with vandyke than with cyanotype or gum bichromate solutions that distilled water be used since the chlorine in tap water can react with the silver nitrate.) Stir each chemical into its 8 ounces of water with a clean glass rod or plastic utensil. Pour the ferric ammonium citrate and tartaric acid solutions together into a quart measuring pitcher reserved for vandyke only. Wearing gloves and protecting your eyes with glasses or goggles, slowly add the silver nitrate solution to the pitcher while stirring. Add enough distilled water to make up 32 ounces of solution. This solution, stored and labeled in brown bottles or dispensers covered in black tape, has a shelf life of 6 months to a year or more, probably depending on storage conditions — a cool, dark storage area is best. After about a year the solution may no longer be able to produce rich continuous tone but still can be used for graphic high-contrast images. Eventually, most of the transparent silver salts will precipitate to the bottom of the bottle in gray flakes and chunks of metallic silver and your print will consist mostly of ferrous ammonium citrate, i.e. rust.

Contamination

Full-bodied tone can also be lost through contamination, a true source of woe for the printer. Vandyke solution reacts with metal, so steel trays and brushes with metal ferrules should not be used. The sponge brushes used for applying vandyke solution should be kept separate and not used for cyanotpe or gum bichromate. Traces of potassium ferricyanide or dichromate in the brush used for vandyke will weaken your print. Your trays should not have traces of these chemicals either. You may need to change the water in the final wash tray if it has been used for cyanotype, gum or palladium.

High Contrast Negative Required

A last warning harks back to the density of your light-resist. *Thin negatives yield muddy prints.* The tonal contrast of vandyke as a process is very low, equal to that of grade 1 or zero enlarging paper. This means that your negative needs dense highlights and open shadows to print a full range of tones. Without dense highlights, in the time it takes to expose to print rich shadows, your highlights will have become too dark.

One of the advantages of platinum/palladium is that you may vary contrast somewhat. With vandyke you have only low contrast. You can make your negatives denser by prolonging development or using a more concentrated developer — but simply overexposing a negative will result in a negative that is dense in highlights *and* shadows, still a low contrast negative. A concentrated selenium solution may boost contrast by attaching to the silver on the negative and giving it a reddish cast, but to use a heavy metal, that is toxic for the human who uses it and for the environment that absorbs it, is to be avoided if possible. Nowadays, instead of using selenium, I would recommend scanning the thin negative, boosting contrast through Levels or Curves in Photoshop and producing a desktop or imagesetter negative that fits the vandyke process. Traditional darkroom photographers are accustomed to finding a grade of photographic paper (or the appropriate filter with multigrade paper) that will give the best rendition of a particular negative. Non-silver photographers often have to craft the large negative to work with the particular non-silver process, especially when printing in vandyke brown. If you have a small format negative that you need to enlarge to print in vandyke there are strategies for boosting contrast that are described in the chapter on “Enlarged Negatives”.

Coating and Drying the Paper

When ready to print, tape your paper to a clean surface so it won’t slide around while you’re brushing on the solution. The coating may be done by tungsten light (such as a 60W bulb several feet away) or by dim daylight. Red or yellow safelights are not needed and pose a safety hazard since the yellowish vandyke solution cannot be seen in such light. There are two basic ways to apply the vandyke solution. The one that I favor is to pour a small amount of the solution into a clean dedicated container and dip into it with a 2˝ Poly-Brush (rather than the finer Foam Brush 8505 that picks up paper fiber). This is a more painterly approach. Avoid brushing to the edges of the paper in order to provide a safe handling margin and to prevent contamination of the drying screen. The second method is to dribble a thin line of the watery solution directly from the dispenser

bottle along an end of the paper and swiftly but carefully pull it across the image area with your sponge or haké brush or with a glass or plastic coating tube. Have a dry sponge brush on hand, however you coat, to absorb excess solution. Don't let the solution lie in puddles or run off the page. If it does dry in puddles you will find that the excess will mask the print and leave white areas where you would expect dark tones.

If the paper you are using has a tendency to curl (as happens with single-ply Strathmore 500), tape it to a piece of glass or plexi, sensitize it, and slide the ensemble into the drying rack. After a minimum of 10 minutes in the dark drying rack, remove the ensemble and, while the paper is still taped down, complete the drying with a hairdryer. If the coating is not completely dry when you make the exposure, dark gray/black streaks will appear on your print — so be sure to feel the back of the paper for cool dampness and flex the paper to see if the center is puffed out with un-dried vandyke solution and can't easily flex back and forth. Also, while flexing the paper, listen for a crackling sound that indicates dryness. Do not touch the sensitized surface of the paper for the sake of your image as well as your skin.

Exposure

A vandyke print takes much less time to expose than a cyanotype. A sufficiently exposed vandyke will look quite *underexposed* before processing whereas a sufficiently exposed cyanotype will look very overexposed. If you are making a vandyke by inspection, expose only until the upper middle tones barely begin to show detail. The print darkens tremendously during both processing and drying.

Test strips are recommended. Be sure to use the same paper that will be used for the final print since the rendition of your negative will vary depending on the kind of paper you print on. Before sensitizing the test sheet, place the negative beneath the paper on a light table and mark areas and times of exposure in pencil using a straightedge. Each exposure on the test strip should include both dark and light critical areas of your image so that you may evaluate both shadow detail and highlight separation. You cannot judge a test strip until it has been processed and *dried*, since it darkens as it dries.

Processing the Print

Three trays are required for processing your vandyke print. The first two should be used exclusively for this process and should be labeled accordingly.

A tray labeled *First Immersion for Vandyke* contains cool tap water.

A second tray labeled *Diluted Fixer* contains 60 ounces cool tap water and 3 ounces *paper strength* fixer. Paper strength means fixer diluted to the point at which it is used for fixing a normal silver gelatin print. The traditional fixer for vandyke is pure sodium thiosulfate, first mixed l cup to a quart of water and then diluted l:20. We use Sprint fixer without the alum hardener. Whatever kind you use should first be diluted to normal paper strength and then diluted again: one part to twenty parts water. Undiluted regular strength paper fixer would have a bleaching effect on the very finely divided silver that constitutes a vandyke image. (I find it interesting that the smaller the grain of silver, the browner the color is, and, conversely, the larger the grain, the cooler and blacker it looks.) The diluted fixer, however, is exhausted quickly and, to be on the safe side, should be replaced after every 8″ x 10″ print plus test strip (or every four 4″ x 5″ prints) that goes through it — or at the least, in time of drought, after every two or three 8″ x 10″ prints.

We used to include a third tray, labeled *Fixer Remover*, which contained a regular strength working solution of a washing aid such as is made by Sprint (mix stock solution from the cubitainer 1:9 with water) or Perma Wash (mix 1 $^{1}/_{2}$ oz. with 2 qts. water). This reputedly helped remove traces of fixer from your print and shortened washing time It was used for the entire session and dumped only at the end. Students tended to go through the expensive fixer remover very quickly, mixing it too concentrated or dumping it prematurely. Since vandyke is not an archival process to begin with and since cotton paper clears much faster than silver gelatin paper and since there is online precedence for omitting this step, we decided to do the same with no observable difference thus far.

The current third and final tray is required for *washing* the print in cool tapwater. It is elevated, usually on top of an upside-down tray, and fitted with a Kodak tray siphon that injects clean water from above and draws out contaminated water from below. If this water has been used for washing prints done in cyanotype or gum, your vandyke print is likely to have some of its richness bleached away. So before you wash your vandyke, carefully remove the tray siphon, bail out and dump the contaminated water, drain the tray, wipe off slime and sludge with paper towels, rinse the tray, replace the tray siphon and refill the tray with cool water.

After exposure to actinic light, slip the printing paper, face up, into the tray of water labeled *First Immersion for Vandyke*. Cover the surface of the print with water. With

tongs, or wearing gloves, lift the sheet and slip it, image-side down, into the water. Heavy unexposed iron and silver salts will drift to the bottom of the tray. Agitate by rocking the tray and laying the print alternately right-side-up and upside-down for two minutes. Then lift the paper out and let it drain. Next slip the print into the *Diluted Fixer* tray face up, cover with liquid and agitate. You will see the image turn from a rusty reddish-tan (the printed-out iron salts) to rich chocolate brown as the silver salts link up with the exposed ferrous iron salts and are reduced to visible metallic silver. Lift the print and replace it face down while continuing to agitate. After two minutes, lift and drain the paper.

The optimum time for the final wash of a vandyke doesn't seem to be common knowledge but in a class situation we average about l0 minutes. A thick, soft paper like BFK Rives will take longer to wash than a thinner, harder paper. Keep an eye on single-ply Strathmore 500 paper as it washes to make sure it doesn't crimp or buckle. Do not use *two*-ply Strathmore 500 because its glue is acidic and can mottle the image and yellow the paper over time.

Test strips do not need as long a washing as prints but should be completely dried for evaluation, not just because of normal dry-down but because the brown of the vandyke gets darker as it dries.

Cyanotype with Vandyke

Cyanotype solution brushed over a processed vandyke will have a bleaching effect. This is not really a surprise since the potassium ferricyanide half of cyanotype chemistry is a potent silver bleach (as well as the source of blue in a cyanotype). If the initial vandyke print is a very strong image, the cyanotype solution will bleach and replace the darkest brown areas with blue only where they are re-exposed to powerful actinic light. This means that a positive image in vandyke could survive on paper with its negative image printed over it in blue. Interesting white lines and complex mossy green effects occur in continuous tone areas where the processes compete. But if the positive image were reiterated in cyanotype directly on top of the positive vandyke, the brown might vanish entirely and you might as well have printed a cyanotype to begin with. (The same goes for printing vandyke on top of cyanotype and I don't have, at this time, an explanation for why cyanotype yields to vandyke.)

PALLADIUM

Palladium and platinum rely on iron salts to react to light, as do cyanotype and vandyke. Upon exposure to actinic light, iron salts are reduced from ferric to ferrous and during development palladium salts that lie in contact with the ferrous salts are reduced to visible palladium metal. The color of a palladium print can range from brown tones that can be confused with vandyke to gray tones that can be mistaken for platinum, depending on the developer that is used.

Palladium and vandyke produce prints with long, delicate tonal scales. However, unlike vandyke brown, the contrast in palladium (and platinum) can be controlled somewhat by two or three means.

Palladium, like gold and platinum, is a 'noble' metal that does not tarnish. It is possible to etch away, with hydrochloric or citric acid, residual iron salts that remain in the paper after a palladium print is developed. This leaves you with an image that is pure palladium — but the acid attacks the paper fiber. In recent years a chelating agent, EDTA, has been used instead of acid to remove the iron salts. It is gentler to the paper fibers than acid. Prints cleared with EDTA will not fade *or* become brittle.

Platinum/Palladium

In the photographic marketplace, platinum is the most highly esteemed of the non-silver processes. Platinum's mystique derives partly from the fact that it is the most expensive non-silver process. Its cousin palladium used to cost much less than it does now. (Unfortunately palladium, among other uses, is now used in the catalytic converters of most cars.) However, at the time this is written, platinum solution still costs more than twice as much as palladium solution.

Historically, platinum prints were known for their subtle grays and palladium prints for their brown tones. This was in the days when platinum and palladium were developed in the traditional developer, potassium oxalate. Photographers often combined the two metals to achieve a range of tones that fell between the grays of platinum and the browns of palladium. Potassium oxalate is a more poisonous developer than ammonium citrate or sodium acetate developers which produce relatively cooler, grayer palladium prints that could be mistaken for platinum prints. Sometimes a palladium print is called a platinum print even if it doesn't contain any of this metal. Also, some workers add a few drops of platinum salts to the palladium salts to ensure dark values that are black because of the tendency of pure palladium to solarize to brown — and/or to boost contrast with a c ertain kind of platinum salt. Such prints are often referred to as platinum prints.

Printing Paper

Your choice of printing paper can make a great difference in the look of a final print. Palladium likes a slightly acidic surface on paper. An inexpensive wood pulp paper that has been buffered to combat its inherent acidity to the point of alkalinity gives a weak image in palladium. A soft cotton paper like BFK Rives soaks up the precious palladium solution and can pill leaving white flecks in the image.

Even a paper created for platinum/palladium, such as Arches Platine, which usually prints beautifully, can, on occasion, to deliver a palladium print that is either mottled or washed out. Photographer John Joyce used Platine for palladium prints for several years with excellent results but then for several months was plagued with mottled or pale prints as well as granulated (rather than smooth) tones. I was told by Kevin Sullivan of Bostick & Sullivan that some of these problems could have been the result of variations in humidity as well as subtle inconsistencies in the manufacturer's sizing of individual mould-made sheets of Platine. I ordered some Crane's Platinotype paper, both bright white and natural, which is manufactured in rolls rather than sheet by sheet and is thus more consistent, but we found that the surface of the Crane's was easily abraded during coating and that it lacked sufficient wet strength to hang from clothespins without being cradled in a hammock of nylon screen. Fortunately, along with the Crane's order Kevin sent samples of Bergger Cot320 paper that held up somewhat better during coating and processing, but with a new batch of Platine, John Joyce is back to using it. Other Pt/Pd printers have recommended Bienfang tracing paper, Opaline Parchment and Crescent paper.

More on Paper

If you are seduced by the sensuous qualities of Arches Platine paper, despite potential problems, and buy a 22″ by 30″ sheet, note which side of it has the right-reading 'Arches Platine' watermark. I used to think that you had to print on the right-reading side with its smooth plate finish, but Eric Kunsman, graduate student in Book Arts/Printmaking, got stronger, clearer renditions of his view camera negatives on the comparatively rough back of Platine. It may be that the infamous run of Platine described in the previous section had overly hard sizing on the smooth side that didn't allow enough absorption of the palladium solution. But another factor could have been the alkalinity of the sizing, according to Kevin's brother, Dana Sullivan. He said that some printers make the smooth side of Platine less alkaline by brushing 1% or 2% oxalic or citric acid

on the image area and letting it dry before coating with the expensive palladium solution. Palladium printers who swore by double-coating the paper with slightly acidic palladium solution were simply making the paper less alkaline using a precious metal, a waste of money and resources. In any case, more recent batches of Platine have printed beautifully on the right-reading side.

It is important to handle whatever paper you decide to use without touching the image area on your paper. Greasy fingerprints can repel the palladium solution, leaving whitish fingerprints. Place your negative/light-resist on the paper just where you want your image to print and, using a pencil, lightly mark its corners. This will guide you in applying the palladium solution. Or, if you wish to coat only parts of the image area, lay the negative on the light table and, placing the paper on top of it, sketch lightly in pencil the shapes of areas you wish to coat.

Mixing Palladium Solution

Traditionally, three solutions are combined, drop by drop, in a clean vessel. (Glass or ceramic vessels work best though hard plastic containers can be used. Kara LaFleur discovered that Styrofoam containers do not work well.) Solution A (#1) contains light-sensitive ferric oxalate. Solution B (#2) is the same as Solution A except that a pinch of potassium chlorate, a volatile oxidizer which boosts contrast, has been added. Solution C (#3) contains the precious palladium salts. According to this method you control contrast by varying the ratio of Solution A to Solution B — with Solution C always the same. The chart below shows what we at UArts have found to be the amount of contrast rendered by various ratios of A to B in terms of graded silver paper and beneath those how the solution will print in terms of relative contrast:

	Grade 0 + v. soft	Grade 1 + soft	Grade 2 - average	Grade 2 contrasty	Grade 2 + v. contrasty
Sol. A	22	18	14	10	0
Sol. B	0	4	8	12	22
Sol. C	24	24	24	24	24

The smoothest, creamiest tones are rendered with the ‘very soft’ combination of 22 drops of A, no drops of B, and 24 drops of C, but to produce a print that isn’t muddy you need a negative with a great range of density. If you give a view camera negative

twice the development time you'd give a negative intended for printing in silver you might have one suited for the 'very soft' mix. At the other end of the chart, to achieve the highest possible contrast, which isn't much more than average contrast in silver printing, use 22 drops of B and no A solution. Try to avoid this combination because the potassium chlorate in B gives a grainy look to the print. 'Contrasty', obtained by combining 10 drops of A and 12 drops of B, gives a boost in contrast to images printed from average negatives that would be too thin to print in vandyke brown. But, and this is a big but, this ratio of solutions cannot compensate for thinner negatives that would need grade 3 or higher silver paper.

We order these 3 solutions already prepared in brown bottles from Bostick & Sullivan (see "Resources"). Since 24 drops of Solution C equals 11/2ml, approximately sixteen 8″ x 10″ prints, with enough excess for test strips, can be produced from a 25ml bottle. Be sure to use eyedroppers of the same design with each solution since the blunt-tipped kind gives a different size droplet from the more commonly used tapering eyedropper that is supplied by Bostick & Sullivan.

Sheer disposable gloves should be used when handling the little brown bottles of palladium chemistry. Heavy reusable gloves are too clumsy.

Combine the solutions in a clean vessel reserved for this purpose.

Sodium Chloroplatinate – Na2 20%

Although using the Bergger Cot320 paper solved the problems of mottling and pale printing, John Joyce still found granulation in midtones and highlights from negatives that he'd printed smoothly from in the past on the old batch of Platine that worked so well. It's true that he was using the contrasty mix with 12 drops of B.

Dana Sullivan suggested a new/old way of printing that his father Richard had picked up on in his extensive readings of 19th century documents. This approach avoids the granularity associated with using potassium chloride to boost contrast and extends the contrast range of palladium. It involves using none of the B (#2) solution and substituting one or more drops of a form of an expensive *platinum* salt in solution called 'sodium chloroplatinate' for the palladium in Solution C (#3). Dana sent a sample bottle for us to try and the result was a perfect print for John Joyce after months of frustration. The black was especially deep and velvety since platinum keeps the palladium from

solarizing (turning brown) in overexposed areas and there was not a trace of granulation. According to Dana, contrast can be extended well beyond what could be achieved with the 'contrasty' mix by substituting more drops of sodium chloroplatinate solution for drops of palladium solution C (#3).

Applying Palladium Solution

Haké brushes are often used for brushing on palladium solution. These wide flat brushes, usually from China, are made of white goat hair, wood and strong thread. There is no metal ferrule to interact with the chemicals and cause trouble. You can trim and bevel the brush to suit your needs. We have also found that sponge brushes work well, especially the narrow 1 or 2 inch size. At the beginning of a printing session your brush, either bristle or sponge, should be dipped in distilled water and then pressed between gloved fingers to remove excess water. The dampness of the brush will prevent some of the expensive palladium solution from being wasted. Witho Worms, a Dutch photographer who makes superb platinum/palladium prints, uses a DaVinci 5080 brush. This expensive brush has very fine nylon bristles. Witho presoaks the brush in distilled water and removes excess water before dipping into the palladium solution. He does this to prevent chemicals from getting into the brush — as well as to conserve. He says that a Richeson brush could also be used.

Apply the solution generously and as evenly as possible onto the paper. Forty-six drops will just cover an 11″ by l4″ area on a hard paper. An 8″ by l0″ area can be covered easily with 46 drops of palladium chemistry with enough left over for a test strip on the same kind of paper. Look at your freshly coated paper from an oblique angle to make sure its surface is covered with solution where you want it to be and isn't puddling. Don't worry if the coating isn't perfectly even looking. Palladium is surprisingly forgiving in this respect. And if a hair or a particle ends up on the wet coated surface, just leave it there until the paper is dry and then blow it off with a hairdryer rather than disturbing the surface of the paper when it is wet.

The most economical way to apply palladium is with a specially designed coating rod (see 'Edwards Engineered Products' in "Resources"), which is essentially a tube with a handle. Tape the corners of the printing paper to a perfectly smooth surface when coating with a rod. Set the rod with its handle away from you at the top of the sheet and distribute the palladium solution along the edge of the rod with an eyedropper. Lift the rod, placing it behind the line of brown solution, and squeegee the liquid across the

surface of the paper towards yourself; lift the rod and drag excess solution back across the image area away from yourself. Hopefully, two passes with the rod will coat the paper evenly but, if not, more passes can be attempted. Practice rod coating with cyanotype or vandyke solutions before trying it with palladium. Be sure to wash the tube thoroughly with water between different processes.

If you are using a thin, single-ply paper, tape it to a clean piece of glass or plexi so that it doesn't move as you coat it. Brush on the palladium or use the rod applicator and then slip the glass or plastic support with the paper attached into the drying rack. This strategy prevents thin paper from curling in upon itself as it dries.

Or you may be working in a space where it is more practical to hang the coated paper from clothespins on a line. Make some arrangement when drying thin paper to ensure that it doesn't curl in upon itself, perhaps by using extra clothespins.

Drying the Paper

Let the paper dry in darkness for about 10 minutes. This allows the solution to spread out evenly. Then, using the hairdryer on its lowest setting, dry the paper as evenly as possible, front and back. If you had taped the paper to a piece of glass or plexi, dry the front first and then un-tape one corner to gently blow warm air underneath the paper before taking all the tape off. Be careful not to blow the air towards yourself because microscopic bits of drying chemicals could be blown into your face and inadvertently inhaled. Do not touch the surface of the coated print to ascertain if it is dry. Instead feel the back of the print. If it is cool this means that the paper is still damp and requires more drying time. If the paper feels room temperature, another test to make sure that the paper is dry is to flex it. It will not flex easily if it is still damp because it will be ballooning out slightly on the coated side. Do not go overboard with the hairdryer on a palladium print since graininess can result. Kevin Sullivan has warned that very low humidity in heated rooms can also produce graininess.

Exposure: Test Strips or by Inspection

Exposure time for a palladium print is much less than for a cyanotype and may be about the same as for a vandyke with the following difference: the more bleach-like Solution B you use in the sensitizer, the longer your exposure time will be. (Those who print on multigrade silver paper with filters know that you have to increase exposure time when boosting contrast.)

A test strip is the surest way to determine an ideal exposure. It *must* be done on the same kind of paper as the final print and under the same conditions. A good test strip goes from underexposed to overexposed to reveal the entire range of possibilities. Each portion of the strip must capture parts of the image that have both highlight and shadow as well as mid-tones. Therefore you have to design a test strip intelligently before coating the paper. Place the negative on a light table and angle the test strip on top of it to capture pertinent information on each portion of the strip and then, with a straightedge and pencil, draw lines on either side of the negative to the edges of the test paper to guide the placement of masking material during exposures. Write the proposed exposure times between the penciled lines on both sides of the negative where they won't be covered by palladium and will be visible to guide you during test exposures. Test strip times vary with the light-resists' densities and the light source. However, a hypothetical sequence of exposures for a continuous tone negative with dense highlights might be 10, 20, 40, 80 and 160 units on our platemaker with its particular calibration. This sequence is a doubling of each exposure rather than adding the same amount of exposure each time as you might do for a flat or relatively thin negative.

Tape one side of the negative to the test strip with two small pieces of clear tape so that the negative can be lifted from the print like turning the page of a book and printing-out can be checked without losing registration. (If you have a traditional split-back contact frame, there's no need for tape since the negative can be held in place against the paper under the unloosened part of the back.)

Expose the entire test strip for 10 units. Then cover the portion that is marked '10 units' with goldenrod (or some other mask that blocks actinic light) and give another 10 units to the remaining four parts of the test strip, bringing their exposure to 20 units. Cover the first and second portions of the strip and expose the rest of the strip for 20 units. Cover portions 1, 2 and 3 of the strip and expose the rest of it for 40 units bringing the total to 80 units. Finally, cover the portions 1-4 and give the fifth portion 80 units to bring the total to 160. Inspect the test strip while leaving the negative taped to it. If substantial printing-out has not occurred on the part that got 160 units, keep adding overall exposures with negative in place but with no masking until such printing-out does appear and revise your test strip times in the margins accordingly.

If you are not making a test strip but are instead printing by inspection, the common wisdom is to expose until there is the faintest indication of highlight detail rendered in rusty brown ferrous tones. (As in the vandyke brown process, the printed-out

palladium image darkens considerably with development, but unlike vandyke it does not darken with drying, though it may dry down and seem to lose contrast.)

Development

We used ammonium citrate as the developer for several years. It is expensive but is used over and over, and replenished with fresh developer to make up for volume that is lost by use. Only once in my experience has this developer expired from overuse. Although ammonium citrate developer is not in itself poisonous (unlike traditional potassium oxalate developer which is quite toxic to begin with), it should be used under a fume hood or outdoors because it becomes contaminated with ferric oxalate that leaches off prints developed in it and fumes from the ferric oxalate can give you quite a headache, something I know from experience.

Over the summer John Joyce tried potassium oxalate developer at the suggestion of Ernestine Ruben to see if he could get rid of granulation in the skies of his landscapes. It worked for him in combination with the sodium chloroplatinate (Na2 20%) and the Bergger Cot320 and he can accept the browner rendition of a print that comes with this developer. Beginning in Fall '03 we've used the potassium oxalate in the fume hood with excellent results.

Slip your exposed test strip or print face up into whichever developer you use and make sure that the entire surface of the paper is covered with developer quickly. This will help to avoid 'lap' marks on your print. Development is almost instantaneous and need not continue longer than one minute with continuous agitation. The palladium salts lying in contact with the ferrous salts will reduce to form the image.

If you can't seem to avoid 'lap' marks on your print, you might try diluting the developer with water. Dana Sullivan put forth this idea but did not give suggestions about how much to dilute it.

Clearing

Before proceeding to the clearing baths, submerge, agitate and flip the print in a tray of plain water, allowing unexposed ferric and palladium salts to slough off the paper and sink to the bottom before proceeding to the clearing baths. Change the water in this tray when it gets murky.

To have a stable print of pure palladium, it is critical to remove the iron salts that initially formed your image. If you don't, these salts can darken later in highlights as sometimes occurs with vandyke brown prints. In the past, hydrochloric acid diluted in water was used to literally etch away the iron salts, but such a strong acid tends to make paper fiber short and brittle. It seemed like an advance to switch to less hazardous, gentler citric acid which we used for a number of years. Over the past several years, however, we have been using EDTA (ethylenediamine tetra-acetic acid) to remove iron salts from the palladium print. EDTA functions not as an acid but rather as a chelating agent that hooks up with the iron molecules and gently removes them from the paper.

Three trays of clearing baths should be prepared. Each of the three trays contains approximately 4 tablespoons of EDTA dissolved in 60 oz. of slightly warm tap water. The powdered EDTA dissolves quickly with a little stirring and dissolves even faster if the water is poured onto the powder heaped up in the tray. Take your newly developed print from the rinse tray to tray #1 and agitate it gently for 5 minutes, much of the time face down. (You can make sure that there are no air bubbles trapped under the face-down print by raking the surface of liquid with the edge of the print to break any visible bubbles and then lowering the print holding it by diagonally opposing corners so that the center of the print touches the liquid first and air bubbles can escape. You will not like what happens where air bubbles are trapped: i.e., brown circles of uncleared sensitizer that are hard to get rid of.) The tan-rust highlights begin to whiten as the iron salts are removed and the tone of the image starts to cool. Move the print to tray #2 and agitate for another 5 minutes. Repeat with tray #3.

Residual yellow in highlights can be removed in a bath of sodium sulfite. The concentration of sodium sulfite is not critical since you will leave the print in it until the yellow has gone away. Witho Worms mixes sodium sulfite *with* EDTA. He combines 30 grams of sodium sulfite with 60 grams EDTA in 4 liters (1 gallon) of water. We now add ≈ 2 tablespoons of sodium sulfite to ≈ 4 tablespoons of EDTA in each tray with good results. Finally, wash the print by itself in tap water with the tray siphon running at a moderate speed for a bare minimum of five minutes with frequent flipping, and preferably for longer when we are not in a drought.

When the solution in tray #1 becomes cloudy after a few prints have passed through it, discard the solution and shift tray #2 into #1's position. Tray #3 moves into #2's position. In the former tray #1, mix EDTA and sodium sulfite in fresh tap water and place it where #3 was. This way the baths will remain most effective and the least

contaminated tray will always be the last clearing bath. At the end of your printing session save the contents of the third clearing bath to use in tray #1 in your next printing session — unless it has been used so much that it is discolored.

Rescuing Palladium Prints

An over-exposed palladium print cannot be bleached back to an acceptable tonal range but, if you are not a purist, you could draw or paint or print on top of it in light, opaque (or semi-opaque) colors to bring back highlights.

If your palladium print is underexposed, you can strengthen it by printing over it again with another coat of palladium, or a layer of cyanotype or vandyke. Cyanotype works especially well to strengthen shadow areas. Its blue coolness contrasts in a satisfying way with the warm gray of the palladium and deepens shadows to a dark pewter color. The cyanotype layer can be bleached to increase contrast without affecting the underlying palladium. Of course you might have registration problems if the paper wasn't preshrunk before you coated it with palladium — people generally don't preshrink paper when they intend to print a single layer of palladium — but on the other hand, paper printed in palladium shrinks less than paper printed upon in gum or even cyanotype or vandyke (for reasons I do not know). Unfortunately we have found that when we print a second layer in any process using the same half-tone negative from the Scitex imagesetter, moiré patterns tend to emerge due to the rows of halftone shapes getting the slightest amount off register. Fortunately, this does not happen with inkjet desktop negatives which are printed in random dots. It can be avoided with halftone negatives by creating a second negative with a different angle to the halftone dots as happens if you go into duotone mode. The shrinkage issue as well as the expense of a second coat of palladium can be gotten around by exposing the duotone separations sequentially onto the same coating of palladium solution. No halftone pattern can be discerned and the print has a velvety richness that rivals the best prints from view camera negatives.

If you print in gum on top of palladium you face sizing issues that are described in the following "Gum Bichromate" chapter, but gum was printed on top of platinum with great success by Edward Steichen. When BFK is sized with gelatin, hardened in formaldehyde and printed upon in palladium, ugly yellow highlights result. Steichen may have gotten BFK to work for him by printing platinum on *preshrunk* BFK which is less fluffy (thus less prone to pilling), and then sizing the paper. Yellow highlights also

appear when palladium is printed on watercolor papers that are pre-sized with hardened gelatin. This yellowing may not appear on paper that has been sized with gelatin but not hardened with formaldehyde which is our new preferred way of working. This is something that should be tried and will be reported on in the next revision of this manual.

I used to warn that printing in gum on top of palladium on Arches Platine is disappointing because the surface that comes sized for printing in platinum/palladium doesn't have sufficient tooth to hold gum emulsion yet stains with freckles of pigment. The part about the freckles is true but it also seemed to me that the smooth surface of Platine would not take gelatin sizing. Once again I have been pleasantly surprised by students who, after printing a layer of palladium, insisted on sizing Platine with two layers of gelatin, and got good results printing in gum over palladium. Special student Michele Robins has now done this successfully many times.

GUM BICHROMATE

Gum bichromate is the most versatile and the most labor intensive process described in this manual. A gum bichromate print can be made in almost any color or combination of colors. Once a gum print has dried after development, it is tough and stable.

The gum process is a fusion of painting, printmaking, and photography. A light-resist, the size of the final image, is usually needed for contact-printing against gum emulsion. The resist functions as a printmaker's matrix or a photographer's negative.

Gum emulsion is a combination of pigment, gum arabic, and orange light-sensitive chromium salts in aqueous suspension. Usually a gum print is built up in layers of transparent or semi-transparent watercolor pigment. A layer of pigmented emulsion is hardened onto a surface by the action of actinic light.

Since layers of gum emulsion are applied by hand with brushes of various sorts, gesture can be subtly (or not so subtly) incorporated into the image. Right after a layer of gum emulsion has been developed in water, it can be manipulated subtractively with a stream of water, or with brushes, or by other means. The surface of a completed, dried gum print, with slightly raised matte highlights and retracted glossy shadows, is almost sculpted in a fine bas-relief.

Approaches to Building an Image in Gum

Digital negatives print well in gum. Nowadays gum workers of ordinary means can produce digital CMYK negatives which can be used to render watercolor approximations of the printing industry's process colors. In this way you can experience first hand the phenomenon of weak individual layers of emulsion accumulating to emerge as a full-bodied gum print with a fairly realistic color approximation of the original.

CMYK separations are by no means the only way to make digital negatives. Different principles, derived from painting and printmaking, can govern the creation of separations and the choice of pigments. In the mode of the printmaker, a layer in Photoshop could be created for each gum layer, and a rough preview of the final gum print with its transparent layers could be viewed on the monitor. Adjustments can be made by creating new digital negatives or masks in response to how the gum print is evolving.

Using just one high-contrast negative, you can produce a gum bichromate image with a range of color by printing in successive layers of color from the same negative and brushing away parts of each layer to reveal underlying colors. For instance your first layer could be blue, parts of which you brush away. If red is the next layer, it would print red where the blue was brushed away and as brown on top of the blue; and blue would show in places where you brushed away the red. A third layer of color manipulated this way, would dramatically extend the palette of the print. And if you did not register the layers perfectly, ribbons of color could wrap around your hard-edged forms.

If a 21-step film scale of densities from to clear to opaque is contact-printed against a patch of gum bichromate emulsion, you will see, after development, that there is gradation or separation of watercolor values in only about 5 of the 2l steps. Below the most saturated of those 5 steps there may appear to be a stepwise darkening but that is a printing-out effect that is caused by the overexposure of dichromate showing through the adhered pigmented gum. The amount of pigment in the gum is finite and must be transparent enough to allow actinic light to penetrate and attach it to paper. The pigmented emulsion in highlights, above what hardened enough to adhere to the paper, may have hardened somewhat on the surface but not enough to hold onto the paper so it sloughs off entirely during development in water.

Using just one continuous-tone (as opposed to high-contrast) negative, one dark color such as lamp black can be printed repeatedly, each layer receiving a different amount of exposure, to produce a monochromatic image with a long tonal range. Each layer of black will print in the shadows creating a black of unsurpassed depth, a few layers will receive enough exposure to print into the mid-tones and only one or two layers will be exposed long enough to print into the highlight areas.

Another approach is to ‘place’ different colors by varying exposure times through the continuous-tone negative. One color is given only enough exposure to adhere in shadow areas; another color gets enough exposure to adhere in the mid-tones; still another color gets exposed all the way into the highlight densities. A potential drawback of this approach is that every color adheres in the shadow areas while it is being exposed to print into mid-tones and highlights. For instance a blue layer exposed just enough to land in shadow areas will change to green if a yellow layer is then applied and exposed to print into highlight areas. This problem can be solved by masking which will be discussed later in this chapter.

For those who like to draw, handmade light-resists, such as drawings and washes on tracing paper or cliché-verre, print well in gum, especially if additions and deletions are made on different layers of emulsion.

Photograms work well in gum. Objects can be 3-dimensional or flat, opaque or translucent. Photogram objects can be added, taken away or moved during the exposure of each layer of emulsion.

If you are at heart a painter, you can do away with light-resists, partially or altogether, and simply paint with the sensitized colors. When the paper is exposed to actinic light, washed, and dried, that layer will not be disturbed as new layers are painted on top. Sensitized watercolor can be handled in this way like glazes of oil paint.

Brief History

Chromium, a relatively rare gray metal, was not identified as an element until 1797. It was given the name for color, 'chroma', because the varied colors of its compounds were used for dyes and pigments. The light-sensitive properties of dichromates, including their ability to harden pigment mixed in colloidal gum arabic onto paper, were known by the 1850s but the gum bichromate process was not taken up in the early years of photography when the main role of the camera was to record and document. It wasn't until the 1890s that gum, with its atmospheric, autographic qualities, was used seriously by photographers who sought to bring the medium into the realm of fine art. A show of gum prints in the 1894 London Photographic Salon by the French photographer, Robert DeMachy, and the English photographer, Alfred Maskell, influenced the revival of the gum bichromate process. DeMachy's gum prints in red evoked sanguine drawings by the Old Masters and his gum prints in black on laid paper seemed like drawings by Toulouse-Lautrec or Georges Seurat. Almost immediately the gum process was taken up by Edward Steichen, and Gertrude Käsebier, both Americans, and by Heinrich Kühn, an Austrian physician— to name just three of the artists.

Steichen, a native of Michigan, was traveling to Paris in 1894 to study painting. He stopped in London on the way and was deeply influenced by DeMachy's and Maskell's gum prints. Steichen changed his first name from Edward to Edouard when he arrived in Paris, took up photography, and found the expressivity of painting within the gum process. He deepened shadows and imparted atmospheric color to some of his

platinum prints with the addition of a layer or two of gum. Other prints he built up entirely of gum manipulated with visible brushstrokes, as in his series on the sculptor Rodin. Profoundly dark masses are in thrilling contrast to sculpted highlights. Explicit detail would be distracting in these prints.

Gertrude Käsebier made gum prints in black on laid paper that look like spontaneous sketches in charcoal. In the collection at the George Eastman House in Rochester, NY, there is a brown gum print of a woman in an interior. The windows are 'blown out' and she didn't hesitate to loosely draw, in brown pencil, the sheer curtains that didn't print.

Heinrich Kühn and other Austrian and German photographers made large gum prints on rough watercolor paper. Their handling seemed to derive from the lithographic tradition. Indeed, many lithographers (including myself much later on) turned from the lithographic stone to the gum bichromate process not just to escape solvent fumes but to enjoy the plasticity of the medium. Kühn took advantage of this to suit his compositional needs. I discovered his alteration by lifting the mat of a gum print of his at Eastman House and seeing that treetops were taller in the image area that was hidden by the mat than in the part of the image that was meant to be seen. Either he opaqued his negative (as Steichen often did) or brushed away the gum rendition of treetops. By whatever means, he bent reality for his artistic purposes.

World War I ended the golden age of pictorialism in which photographers saw themselves as fine artists, and gum printing fell out of favor. Edouard Steichen became Edward again and abandoned gum to work as a Naval photographer. After the war he became a famous fashion photographer and later, after World War II, he curated the Family of Man exhibition of photographs at the Museum of Modern Art. This exhibit influenced many young photographers in the 1950s (including myself at age twelve — it was the first photography book that I purchased).

Kodak reigned supreme until the late 1960s and early 70s when photographers in the Rochester area, tiring of manufactured photographic papers and longing for the mark of the human hand, began researching 19th century non-silver processes at Eastman House where the notebooks of earlier gum printers were available for study. Betty Hahn, Bea Nettles, Robert Fichter, Judith Harold Steinhauser and Patricia Dreher were some of the pioneers in the revival of non-silver processes in upstate New York.

Meanwhile, Lois M. Johnson, then a graduate student in Printmaking at the University of Wisconsin in Madison, saw a cliché-verre gum bichromate print by Camille Corot and was inspired to research and experiment with the gum process. Lois came East to join the faculty of the Printmaking Department of the Philadelphia College of Art (later to become The University of the Arts). She taught a class called 'PhotoMedia' in 1973 that introduced gum bichromate as well as cyanotype along with photo-screenprinting, photo-etching and photo-lithography. Patricia Dreher had moved recently from Buffalo to the Philadelphia area and we signed up together for Lois's innovative class. Patricia taught me the vandyke brown process in the mid-70s. Later, Jerome Kaplan, chairman of Printmaking at PCA back then, invented a brownish-black light-resist that he brushed onto vellum and scratched into. He then printed from the vellum in gum and vandyke, processes that he too had learned from Lois Johnson and Patricia Dreher.

During the same time artist Phil Simkin had us all working to assemble pinhole cameras for a project at the Philadelphia Museum of Art (see 'Pinhole Photography'). This initiated my interest in pinhole photography which was further stimulated when I met Eric Renner, pinhole guru and founder of the *Pinhole Journal* at a conference of the Society for Photographic Education in Baltimore in the early 80s. Eric and I taught together at Tyler School of Art one summer in the late 80s. He taught the pinhole part and I taught how to print from pinhole negatives in cyanotype and gum.

Also in the early 80s Tom Davies, co-founder of The Photography Place in Philadelphia, gave an influential workshop on daguerreotype called 'Time Warp'. A few months later, Tom Shillea, recently arrived in Philadelphia from RIT, demonstrated platinum/palladium printing at The Photography Place and later at PCA.

Judith Harold Steinhauser became an influence in the Philadelphia area when she arrived to teach at Moore College of Art. Her gum prints seemed to deconstruct the medium. Her loose brushstrokes revealed how one layer of color applied over another created a third color.

Martha Madigan of Tyler School of Art made huge cyanotype photograms on rolls of BFK Rives paper. Later she worked with photograms on silver chloride printing-out-paper which is about as light sensitive as gum bichromate emulsion. Catherine Jansen of Bucks County Community College created an entire room out of figures and objects printed in cyanotype on cloth. Book artist, Enid Mark, learned cyanotype and vandyke and incorporated those processes into her books. Although these artists did not print in gum, their work had some of the same roots.

Alida Fish, known already for her gum bichromate prints, came to the Philadelphia College of Art in the late 70s and after a while Jeannie Pearce, also known for her work in gum, arrived at PCA. Twenty years later, both Jeannie and Alida were pioneers in digital imaging at what was by then UArts.

In the 80s and 90s, newspaper photographer Don Camp created enormous casein portraits from lith film using soil as pigment mixed with milk protein and dichromate. He taught casein printing to Rosae Reeder who was at the time a graduate student in Book Arts/Printmaking at UArts (see Rosae's chapter on 'Casein Printing').

Absorbing these influences, I began printing from pinhole negatives in cyanotype and gum bichromate. I combined the two processes after seeing a show of cyanotype/gum prints by Tony Romano, now deceased, at the Philadelphia Art Alliance around 1980. I liked the way the crisp intense blue of cyanotype in shadow areas looked under layers of black and red gum. For 20 years I printed this way from pinhole negatives.

In recent years I have been printing, still in cyanotype and multiple gum layers, from desktop negatives created by scanning and composing in layers from a single black-and-white pinhole negative, or collaging in layers from multiple pinhole negatives. More recently, I have been using small files captured with a digital camera and printing somewhat fragile CMYK separations onto cheap inkjet acetate. When I get a new printer with archival inks I will produce more desktop negatives printed onto better inkjet films and vellums. Meantime I'm using a Scitex imagesetter at UArts that produces smooth lith film digital negatives (in half-tones only), up to 18″ x 24″ in size, that cost less than what a commercial lab would charge. At 200 lines per inch, the halftone pattern is scarcely visible to the naked eye in one printed layer of gum and quite invisible if 4 CMYK layers are printed on top from 4 differently angled separations.

Ernestine Ruben, already well known for her platinum and pulp paper prints, is now working in gum and extending the possibilities of the medium in a painterly manner. For several years she has been a guest critic for the advanced non-silver students and a special mentor for a number of them. She told me about the online Alt Process List (see "Resources") which I joined and participated in for nearly two years. For me it was a graduate school in non-silver processes from which I gained almost more information than I could absorb. It was great to read the emails of participants from all over the world who brought their expertise from incredibly diverse backgrounds to bear on alternative processes of all sorts. I had to leave the List, at least for now, to center on my own

experience of gum and other processes, and also simply to find the time to rewrite and expand this manual, but I recommend it as a forum on alternative processes.

A new generation of gum printers from the Philadelphia area includes Mira Adornetto, Clare Amarakoon, Christopher Dardaris, Sandra Davis, Karen Fiorito, Rebecca Gilbert, Stuart Goldstein, Melissa Good, Matt Hollerbush, Jahjehan Bath Ives, Joe Ives, John Joyce, Karen Lefkovitz, Dana Leight, Martin Lennon, Dave McKenzie, Scott McMahon, Laurie Beck Peterson, Rosae Reeder, Suzanne Solis, Lori Spencer and Evan Woldow. These artists, and others that I apologize for neglecting to name, sustain and extend the revival of non-silver processes, and in particular of gum bichromate.

How it Works

In the gum bichromate process, watercolor pigment is blended with viscous gum arabic, sap of the acacia tree. The resulting pigmented gum is combined, usually 1:1, with an orange solution of light-sensitive chromium salts. This emulsion can be brushed onto the surface of paper that has been sized (see 'To Size or Not to Size' later in chapter), without soaking into its fibers. This is in contrast to watery chemical solutions, like cyanotype, vandyke, and palladium, that soak into paper or cloth and must lie in contact with organic fibers to reveal their full tonal range and intensity. Gum emulsion can be applied to non-organic synthetic surfaces as long as the surface provides enough 'tooth' for it to adhere in image areas. When an exposed gum print is submerged in water, the emulsion including the orange chromium solution releases in highlight areas that were not exposed to actinic light and remains attached where exposed to actinic light.

Minimally exposed areas, that received just enough actinic light to attach pigmented gum to the support, are soft and vulnerable to marring until the print dries. The orange dichromate solution mostly washes out and these passages can be deleted if desired with a spray of water or gentle brushing.

If any more than the minimum exposure is given through the negative, a printing out of the chromium salts, in tones ranging from yellow/beige to a fairly dark brown, will begin to occur beneath or within the pigmented image. For some reason this aspect of the gum process is seldom discussed. It is like an ochre under-painting and adds warmth and depth to the gum image while skewing the watercolor hue. When exposed through a negative with a wide range of densities, a single layer of gum can produce multiple hues in the developed print. For instance, a layer of emulsion containing blue watercolor can

range in hue from pure blue in areas that received just enough exposure to adhere the emulsion to more heavily exposed areas in which the yellow/beige/brown printing-out of chromium salts turns the blue into various shades of green.

While the print is still wet from development, the blue passages in the least exposed areas can be deleted, if desired, with a spray of water. Mid-tone passages, in which the blue looks light green after development, received more than the minimum exposure. Pigment in the mid-tones can be brushed off usually, but the embedded chromium salts, that received exposure beyond the minimum needed to adhere the pigmented gum, will print out in shades of golden tan that cannot be deleted manually. These tans can later be removed in a bath of sodium bisulfite, after the print has dried and hardened overnight.

Shadow areas, that received the greatest amounts of actinic light, adhere, locking pigment onto the support, and printing out, along with the pigment, to produce greenish brown hues. It is difficult to lift or manipulate gum colors that have received this much exposure. The darker tans, that print out in these open areas of the negative, can be changed from brown to light gray/green during clearing in sodium bisulfite but do not vanish entirely.

A full-bodied image in gum is created, usually, with multiple layers of gum bichromate in varying hues and concentrations that are exposed for varying amounts of time and developed with varying amounts of manipulation. Unless the negative consists of entirely clear and entirely opaque film which can be given just enough exposure to adhere the pigmented gum, there will be at least some printing-out of chromium salts in the more open parts of the negative for each layer of emulsion.

Chromium Salts: Ammonium versus Potassium

A note of clarification: the words dichromate and bichromate are interchangeable. In this manual the nineteenth century 'bi' prefix refers to the gum bichromate process in deference to the artists who first used the medium, but the 'di' prefix is used to refer to the chromium salt by itself and is what you will find in chemical catalogs today.

Ammonium dichromate and potassium dichromate both exhibit two important printmaking characteristics already described: l) with exposure to actinic light they harden gum arabic with its cargo of pigment onto a support; 2) with further exposure both chromium salts print-out in shades of tan within the adhered emulsion.

But there are some differences between these chromium salts. Ammonium dichromate is more soluble in water than potassium dichromate which means that with a more concentrated solution exposures are quicker and more prints can be made within a finite period of time. For that reason we have been using ammonium dichromate in class. However, if you are working at home and using the sun as an actinic light source, the difference between a one minute exposure in the sun using ammonium dichromate and a two minute exposure using potassium dichromate may be insignificant.

Ammonium dichromate, the more expensive of the two salts, is combustible and is shipped as a hazardous chemical for an extra $25.00 within the U.S.; potassium dichromate (which was used more commonly in the past) is not combustible and can be shipped in the conventional manner — although some suppliers don't seem to know this.

As I said, we have been using ammonium dichromate. However, now there are additional actinic light sources in Printmaking, so we will begin to use up an old 5 lb. jar of potassium dichromate powder that was given to us. I used it last summer and although it may be 30 years old it worked fine.

Taking Precautions and Safeguarding Your Health

According to *Overexposure: Health Hazards in Photography* by Susan Shaw (published by The Friends of Photography, 1983), "Ammonium dichromate is moderately toxic by skin contact and by ingestion; it is highly toxic by inhalation. Dichromates are also suspected carcinogens. Skin contact can cause irritation, allergies, and possible ulceration…" Since 1983 it has been shown that dichromates are indeed carcinogenic. The liver cannot eliminate heavy metals such as chromium. Chronic exposure to chromium salts through skin contact, inhalation or ingestion could eventually cause liver cancer. Short of liver cancer, chronic exposure can induce asthma, other allergic reactions and skin ulcers. So, handle the bright orange dichromate crystals and solutions of dichromate carefully, with adequate protection!

However, if you should get a few drops of dichromate solution on your skin, do not panic. Immediately wash the exposed area thoroughly in cool running water. Usually it is repeated or prolonged skin contact that poses a problem.

If you should get dichromate in your eyes, flush them immediately and for several minutes with water (at school use the eyewash fountain) and seek medical attention. Launder contaminated clothing.

The dichromate is still 'hazardous' when you are registering negatives so avoid touching the dry sensitized emulsion. But, once a print has been developed, thoroughly washed, and dried, whatever remains of the dichromate is locked into the emulsion and the paper and no longer poses a hazard in handling the print.

If you are planning on working in gum at home (which means bringing chromium salts into your home), don't prepare your dichromate solution with containers or implements that may be used for cooking or eaten from in the future. Don't mix or apply dichromate in your kitchen. Label all bottles and jars with the name of the chemical, its concentration when in solution, the date it was mixed and a warning. Don't work with flammable ammonium dichromate near an open flame. Don't allow crystals to build up on the mouth of a dispenser because they could crumble and then become airborne (this is true at school too). Wash and dry such surfaces. At home in my work area I dispose of contaminated rags, paper towels, stirring sticks, etc. in a closed can lined with 2 recycled plastic grocery bags, one inside the other. I carefully tie the outer bag closed on itself before it gets too full so that dust from dried dichromate won't escape in the face of anyone who handles the trash

Be sure to keep dichromate out of reach by children especially since they may be attracted to the bright orange crystals or assume that the orange solution is a beverage.

If you must dispose of more than an ounce or two of dichromate solution, make certain it is clearly labeled and take it to a hazardous waste pick-up point. Most communities have such pick-ups scheduled at least twice a year. But try not to order and mix into solution more than you can imagine using. The dichromate crystals will keep in a sealed jar indefinitely and in solution it remains potent for a number of years.

During the 25 years that I have been teaching non-silver processes, including gum printing, I am aware of nobody who has been injured other than myself. Years ago, while helping students register negatives on their sensitized gum prints, I must have gotten a bit of dichromate lodged under the cuticle of my little fingernail. I did not wash my hand thoroughly and an abscess formed. Eventually I lost the fingernail. Although it did grow back, this incident made me more respectful of potential hazards and the need to maintain fastidious work habits.

Chromatype

It is possible to make a print in delicate shades of tan (that may turn slightly gray/green over time) applying liquid dichromate by itself to paper without pigmented gum. Somewhat warily, I call this a 'chromatype' based on this word's definition in my 1933 edition of *Webster's New International Dictionary in English*: "A picture made upon paper sensitized with potassium dichromate or some other chromium compound." (It is possible that the expression 'chromatype' refers to all of the many processes — including gum, casein, carbon, photogravure, and the older generations of photo-lithographic plates and screen-printing emulsion — that rely on the light sensitivity of chromium, but I am interpreting the definition to mean dichromate used alone.)

Chromatype exposures need to be many times longer than for gum bichromate prints since you are making an image out of the secondary underprinting that comes with overexposure of a gum print. Like cyanotype, vandyke, and palladium, a chromatype image is formed around and within the organic fibers of paper by a watery chemical solution (as opposed to within an emulsion on top of sized paper) which gives a fine but limited gradation of tone from yellow to brown. Since usually dichromate solution is brushed onto un-sized paper, there is no curl from sizing or gum layers to contend with. The negative should be hinged on one side with two pieces of clear tape, as is done for the iron processes covered in this manual, so that exposure for a chromatype can be judged by inspection. The printed-out image should look over-exposed since quite a bit of yellow/tan in the highlights will wash out during development in water. If, on the other hand, the developed chromatype looks over-exposed it can be reduced by bleaching the print in sodium bisulfite or its substitutes (see 'Clearing a Gum Print').

Gum Arabic

Tears of gum arabic (like tears of pine resin) are harvested from the thorny acacia tree in Arabia and North Africa by Bedouin tribesmen. Burlap sacks of the rough bits of gum are delivered to processing centers where the gum is refined into various forms and degrees of purity. In the past 30 years the price of gum arabic has risen from $3 a gallon for lithographer's gum arabic solution to nearly $30 a gallon as demand for it has increased and supply has dwindled due to drought and other factors — such as elephants scratching their backs on the acacia trees and knocking them over. One hundred years ago, a gum printer would suspend the unrefined amber pieces of gum in a cheesecloth bag in water overnight. By morning the gum dissolved in water would

have formed a syrupy liquid known as a 'colloid'. Its specific gravity should have been somewhere between 12˚ and 17˚ Baumé but I imagine that, as is true with experienced cooks, the correct viscosity of the gum was achieved intuitively. A colloid is a viscous liquid whose particles stay in suspension and do not sink to the bottom as sediment. Egg white (albumen), gelatin, and casein are also colloids that have served as emulsions for dichromates, silver salts and other light-sensitive materials. The homemade colloidal gum had to be used right away since, unlike maple syrup, it did not have much sugar to preserve it and, with its pH of about 5, was a suitable culture medium for micro-organisms. Today gum arabic is refined and hydrated to a viscosity of 14˚ Baumé for lithographic purposes. A strong preservative is necessary to keep it from going sour and although it is not listed as an ingredient on gallon containers of gum arabic, I have heard that mercuric chloride, formaldehyde or thymol is used as the preservative. As a lithographer I loved spreading the gum arabic on the stone or plate with my bare hand but now I might wear a surgical glove. The gum arabic that is used in foods must have more benign preservatives such as sugar.

One Coat versus Layers

The first time I printed on my own in complete gum bichromate emulsion, back in the late 1970s, I decided to make a strong black image using a single exposure from a high contrast lith negative. (See chapter on "Making Enlarged Negatives".) I stirred quite a bit of powdered black pigment into 14˚ Baumé gum arabic, combined it 1:1 with a solution of ammonium dichromate, and coated BFK Rives paper with the resultant opaque black layer of emulsion. To lock the black onto the paper I exposed the contact frame, with my negative pressed against the sensitized paper, to midday sun for half an hour — this is about 30 times more exposure than I would give today. To my surprise and disappointment, the entire emulsion lifted off in the water. Eventually I understood that actinic light must be able to penetrate the pigment to effect the chemical reaction that hardens pigmented gum and attaches it to paper. I had coated with emulsion that had such a high concentration of black pigment that actinic light could not penetrate to adhere the emulsion to the paper fiber. If the white of the printing paper is not visible beneath the emulsion, as if seen through a color filter, an image usually cannot adhere and the emulsion sloughs off during development in water.

Occasionally, with the right combination of negative, pigment, and printing paper, a satisfying gum print is made with a single coat of emulsion. Demachy is known to have printed some of his most famous gum prints that way, according to Judy Seigel, editor

of *Post-Factory Photography,* Issue #6, page 33 (see "Resources"). I encourage students learning gum to bring any paper they want to print on in the beginning and to try pigments of all sorts. In my experience, however, rich gum prints are usually built up on sized paper in increments, layer upon layer.

Two Part Emulsion: Pigmented Gum over Dichromate

When I introduce students to gum printing, we start out by making prints in chromatype (dichromate in solution by itself) so that they understand the phenomenon that occurs in a gum print when exposure goes beyond hardening and into tanning. Any kind of white paper with wet strength will do. Often the resultant print is quite appealing with delicate golden tones ranging into browns and occasionally we get a 'keeper'.

The next exercise builds on the chromatype and was inspired by an article in an old copy of *Photo Miniature* that Paul Cava, Philadelphia art dealer and artist, lent to me decades ago. Unfortunately I did not record the name of the author and nowhere else have I seen or read about this approach which permits an especially free use of gesture and color in gum printing. Some of the non-silver students, especially Painting, Illustration, and Printmaking majors, choose to work in this manner even after the complete emulsion has been introduced.

With the class gathered in the non-silver darkroom under tungsten light, I coat a taped-down sheet of un-sized BFK Rives with ammonium dichromate, leaving white margins for safe handling. It is unnecessary to size the BFK Rives used for this exercise.

On the coating table is a collection of pigments mixed with gum in little jars or plastic film cannisters. One by one each student picks a pigmented gum color, stirs it with a stick of matboard (the pigment tends to settle on the bottom), pours a small puddle of it onto the sensitized BFK and brushes it out with a dry 1″ sponge brush in a patch or arabesque on the paper. At first the paper is quite wet with deep yellow dichromate and the pigmented gum bleeds like watercolor into it, but by the time the last students (in a group of 10-12) apply their areas of color, the dichromate is nearly dry and the pigmented gum sits on top of it without spreading. Some students leave the pigmented gum puddled while others brush it on thinly and overlap with other patches. There is usually an observation made on how the color of the pigment is skewed by the deep yellow dichromate. When the paper is dry the students lay flat objects and hand-drawn light-resists, as well as negatives and printed matter, upon the paper.

The ensemble is given a prolonged exposure in our platemaker, at least three times as long as might be used for a complete emulsion in which pigmented gum and dichromate are mixed and applied together. This is because extra time is needed for light to penetrate the upper layer of pigmented gum and adhere it to the dichromate and the paper. Registration of the diverse light-resists would be lost by opening the platemaker to check underneath them for signs of printing-out, and, in any case, the materials have such a wide range of densities that no single exposure would work for all — hence the rough estimate of exposure time.

When the print has been exposed and removed from the platemaker, we note how the dichromate has darkened in the areas that were not covered with pigmented gum or light-resist, and how tanning shows through the pigmented gum, strengthening the rendition of light-resists but now affecting in a different way the hues of the watercolor pigment.

As the exposed print is slipped face up into a tray of water and gently rocked in the tray, the students have their first view of unexposed pigmented gum and dichromate releasing from the BFK. It is usually a surprise for them to see that heavy blobs of pigment are also sloughing off, even where they were given full exposure. This provides an opportunity to explain that actinic light could not make it through the heavy pigment to adhere it to the dichromated paper.

Lifting the print with gloved hands and immersing it face down and then lifting it again and slipping it back in the tray face up with unexposed pigment and dichromate streaming off the emerging image, it is usually apparent that blue and violet passages have gotten more exposure and are adhering more than red, yellow or brown passages. This demonstrates the fact that actinic light travels easily through blue and violet but has a harder time penetrating warm colors that partially mask themselves. It also becomes evident that some light-resists were suited to the exposure time and rendered well while others were so dense that only a white silhouette was recorded. Still other light-resists may have been so thin that the renderings are quite filled in.

If the light-resist was underexposed and washes off there is nothing to do but recoat the paper and give a longer exposure or find a more open light-resist. If the rendering is filled in from overexposure, subtractive manipulation often can open up highlights and mid-tones.

It is a common mistake of students to begin brushing the surface of a gum print after it has been in water for only a minute or so and then to be disappointed that detail they wanted is gone. Some of the subtlest, most beautiful gum passages are lost by this harsh approach. But since beginning students tend to overexpose, this premature brushing often becomes a way of working, for better or worse.

Manipulation of Gum Prints

Manipulation should be done in stages, beginning with the gentlest and ending with the harshest. After water development image-side-down with some agitation from rocking the tray, and after carefully flipping the print face up and face down without marring its soft surface, and after a final wash with a tray siphon, face down and face up until yellow dichromate no longer drips from it, lay the wet print face up on a piece of plexi and gently direct a small stream of cool water in a margin of the print, tilting the plexi so that water flows across the area you wish to open up or manipulate. If nothing releases, aim the stream of water directly onto the targeted area. Next, increase the impact of the stream of water by pouring it from higher up or squirting it under pressure through a hose. If there is still no release, slowly bring up the temperature of the water. If even hot water has no effect, only then should you resort to using a soft, wet 1″ sponge brush or some other soft brush to lightly stroke the area you wish to brush away while directing cool water onto the area. Next try a dry 1″ sponge brush, which is more abrasive than a wet one, still flooding the area with cool water. Raise the temperature of the water and strength of the spray. If still no release has occurred, take a piece of wool etching blanket or the equivalent and gently rub it on the recalcitrant area. A last resort would be to mix an alkali such as household bleach (sodium hypochlorite) or washing soda (sodium carbonate) with water in a graduated cylinder, apply some with a sponge brush, allow it to sit for a minute or two, and then hose or brush the area and see if the tough bonds of dichromate have been loosened (see upcoming section on ‘Gum Bichromate Solvents’).

Finally, after the print is completely dry, it can be cleared of as much of the tanning as possible (see next section) so that the hues of the watercolors reveal themselves.

Clearing a Gum Print

If too much tanning has taken place in either a chromatype, or in a gum bichromate print (usually after several layers), the offending golden/brown tones can be removed in a bath

of approximately 5% sodium bisulfite (or sodium metabisulfite – or even sodium sulfite) which, being a weak acid, also further sets and cures the image. A more concentrated mix of the clearing agent can be applied locally and then washed off. It is important that the print be completely dry since otherwise some of the pigmented gum that hasn't hardened may release, damaging the print and contaminating the clearing bath.

The sodium bisulfite bath should be mixed and used outdoors or under a fume hood because it smells bad and is very irritating to the respiratory system. I dissolve about 2/3 of a cup of sodium bisulfite powder or crystals in a gallon of tap water. (The exact strength of the solution is not critical since the clearing is judged by eye but it is best not to have it so strong that its action cannot be halted quickly by slipping the print into a tray of plain water — or so weak that you stand around waiting forever.) Sodium bisulfite crystals take longer to dissolve than its powdered form. The solution can be reused to clear dried gum prints until it turns a pale blue/green at which time it should be discarded.

Keep a tray of water right next to the sodium bisulfite bath to stop its action in case only partial clearing of tans is desired and also to remove some of the acidic clearing agent before putting the print in the final wash tray to remove whatever remains. Dark brown tanning does not clear entirely but turns a pale gray/green which might make a gum print cooler than intended.

Recently I learned from *The Book of Alternative Photographic Processes* by Christopher James (2nd Ed. Delmar, 2008), a book that I highly recommend, that sodium sulfite, which we have on hand to clear the yellow out of palladium prints, can be substituted for sodium bisulfite to clear gum prints. The concentration of sodium sulfite needs to be doubled, at least, and the action is slower, but it is effective — and odorless!

Preshrinking

Stepping back to the beginning of the process, preshrinking your printing paper will give dimensional stability to a gum print which it needs if it is going to be built up in registered layers. If you are not working with photographic duotone or CMYK separations, close registration may not be an issue with your particular images and you can skip this discussion.

Sometimes the act of sizing with hot gelatin is equivalent to preshrinking the paper, at least for gum prints that are 5″ x 7″ or smaller. But for 8″ x 10″ prints and larger it may

necessary to preshrink paper in a tray of very hot tap water for about 10 minutes as you might do with clothes that you want to make smaller. It is possible to preshrink up to 12 or 16 quarter sheets of BFK in a 14″ by 17″ tray that is nearly full of hot water but the sheets must be lifted and interleaved to eliminate air bubbles and to ensure that they are evenly wetted. Then hang each wet sheet by a corner from a clothespin and rotate corners as drying proceeds to avoid distortion of the soft wet paper as you would do with laundry.

Judy Seigel told me that a 36 hour soak in room-temperature water is superior to a brief hot water soak for preshrinking. I tried it and indeed paper soaked that way shrank a bit more than paper that was submerged in hot water for much less time. So if you have the foresight, time, and space in which to do the long room-temperature soak, you'll be saving the fuel that's consumed heating water — and getting a better result.

To Size or Not to Size

To be a successful gum printer you need to think empathetically about your materials and imagine action on a scale that you can't see with the naked eye. Picture yourself scaled down to the size of a dust mite on the surface of an un-sized piece of BFK Rives, a soft printmaker's paper. As a dust mite you will find yourself in a white undergrowth of rough cotton fibers that can snag jagged flakes of watercolor pigment and not let go — even in areas that received no exposure. This means that freckles of color (trapped pigment) sometimes remain where the print should have clear white highlights. These dots of color may be acceptable and even desirable; but if you definitely want clear un-freckled highlights, you need to apply a gluey substance called 'sizing' to coat the rough fiber enough so that pigment can release. Imagine ice coating every fiber so that unexposed flakes of pigment can slip out of the smoothed, iced underbrush and rise into the wash water. It may help in understanding the sizing issue to realize that flakes of pigment are enormous compared to molecules of dichromate or iron salts and present a physical rather than a chemical challenge.

To Size

BFK Rives is a French 100% cotton paper commonly used for etching and lithography. It is what Steichen and others printed upon in gum over 100 years ago. The paper is very familiar to me as a printmaker. It is moderately priced and commonly available at art supply stores. The fact that this paper is still being widely used gives me a sense of

continuity with the past, despite two World Wars and everything else that has occurred in the past 100 years…

Preparing to print, I look for the water mark that says 'BFK Rives, France ∞' in the lower left corner of a horizontal full sheet of BFK (either 250 or 280 gram, one a little thinner than the other). On the side that is right reading, I put small x's with an HB pencil in the three corners that don't have the water mark. This is to remind myself that this is the side I wish to print on. I choose the right reading side because it is a little fuzzier and provides more 'tooth' for the emulsion to adhere to, but either side will work with BFK (unlike some papers which are made to be printed on a specially coated side).

I then proceed to tear a 22″ x 30″ sheet of BFK into 11″ x 15″ quarters upon which I intend to print from 8″ x 10″ pinhole negatives or slightly larger digital negatives. (Printmakers are taught to tear their paper rather than cut it so that the torn edges vaguely resemble the deckle at the ends of each sheet.) This is followed by preshrinking as described above.

I heard or read somewhere that the l9th century gummists used gelatin/formaldehyde sizing. (Since I am not a scholarly historian but rather a transmitter of lore, I hope that I can be forgiven for lack of references.) You will read and hear of many ways to size paper nowadays. With my own prints for many years I sized BFK with two separate sheer brushed-on coats of gelatin dissolved in hot water and then immersed the dry gelatined paper in a very diluted formaldehyde bath. The two thin layers of gelatin coat the cotton fibers of the paper without smoothing them or filling them in, but leave a good 'tooth' for the emulsion to grab onto. I've discovered that it really is necessary to coat twice initially to avoid freckles of trapped pigment in highlights.

The formaldehyde bath hardens (polymerizes) the gelatin sizing, making it tougher like hardened plastic. As I was going through the archives at the Visual Studies Workshop in Rochester, NY, I saw insect egg sacs on unprinted paper samples sized with unhardened gelatin decades ago. I saw no evidence of insects on unprinted paper samples sized with gelatin hardened in formaldehyde. However, once a layer of gum bichromate emulsion is printed on paper with unhardened sizing, the gelatin becomes less available to little critters because wherever the emulsion is printed, dichromate has hardened the gelatin in another way – with crystalline lattices rather than polymer chains.

Various starches, glues, and acrylic mediums have been recommended for sizing in recent decades. These methods seem to work better in some hands than in others. Whatever kind of sizing you use, be sure to note it on your paper since it is not always apparent to the eye or the hand. If you apply sizing on just one side of the paper as I do, note which side is which. As you grow accustomed to your paper, you will be able to feel the difference between front and back, sized and un-sized, but fine discernment can be hard to summon when you are in a hurry and you will appreciate having made notes on the paper itself.

Gelatin Sizing

To make gelatin sizing, sprinkle one level tablespoon (or a Knox packet) of unflavored gelatin as evenly as possible over the surface of 1 cup (250ml) of cool tap water in a saucepan and let it sit for at least l0 minutes as the gelatin absorbs water. I have found that any kind of gelatin works, as long as it is unflavored…. (In the past few years I have been printing on gelatined paper that I don't harden in formaldehyde with excellent results and the added benefit that cyanotype can be brushed onto and printed on top of gum layers without beading up.) In a double-boiler or crockpot that keeps the gelatin solution away from a direct flame, raise the temperature of the gelatin-water to about 130˚F. (Many times the gelatin has gotten much hotter than 130˚F with no ill effects which makes sense since gelatin for cooking is nearly brought to a boil.) If you don't have a thermometer, test the temperature with your fingertip. It is hot enough when you can't keep your fingertip immersed. Just before applying the first coat of gelatin, write 'gel 1' in the margin of your paper.

Maintain that temperature range and dip a wide (4˝ or so), soft sponge brush into the hot gelatin and gently apply it to your taped-down paper so that the surface is evenly coated but not dripping. Leave margins un-sized to avoid gelatin build-up on the coating surface, and to avoid gluey edges that can stick to clothespins. Look at the paper at a 45 degree angle to make sure the image area is entirely coated. If you are going to hang the paper to dry, make your last brushstrokes horizontal in regard to the first hanging position. Place the clothespin in the middle of one of the ends of the sheet so that the tendency of the gelatin to flow downward is counteracted by the direction of the last brushstrokes. Make sure the wet gelatin surface does not touch or graze anything. When the paper feels dry and you are ready to apply the second coat of gelatin, write gel 2 in the margin and repeat the coating procedure but this time apply the gelatin less liberally, using a fresh soft dry brush, if necessary, to pick up excess. The paper will feel smoother as you apply the second coat. Hang the paper to dry again.

A down side of my approach is that my paper, sized, and then printed upon on one side only, curls inward. I counteract this tendency by flattening sized paper, once it has dried thoroughly, under heavy plate glass on sheets of foam. Since I also flatten the same paper between each layer of gum printing, I don't have a problem with curling and my finished prints lie flat. Some people immerse their paper in a tray of gelatin and squeegee the excess off of the paper but it is difficult to maintain the right temperature for the gelatin in a tray and the squeegee operation can become quite a mess in a classroom situation. The benefit of total submersion is that with gelatin on both sides the paper does not curl — at least before printing commences (when the gum layers also cause the paper to curl inward). You could *brush* gelatin on both sides of the paper to reduce curling which would require 4 separate coating and drying operations.

Hardening with Formaldehyde

I hesitate to recommend the diluted formaldehyde bath, for fear of its being used in an improperly ventilated area. The fumes are irritating to the respiratory tract and in prolonged and high concentration can polymerize lung tissue, induce allergic asthma and do other damage. Pathologists who hunker over tissue preserved in formaldehyde are said to have the highest incidence of brain cancer of any group. If a fume hood is not available and you cannot work outdoors, skip the formaldehyde bath and make do with unhardened gelatin. The gelatin may wear off through the abrasion of brushing emulsion on and manipulating the print during development, and it will dissolve and wash off in non-printed areas (just where you want it to stay) if subjected to water temperatures over 80˚F, but a fresh layer of gelatin can be applied before each new coating of emulsion. This is how Lois Johnson worked, using fairly high contrast lith negatives. Melissa Good makes prints from inkjet separations sizing with 2 layers of unhardened gelatin and doesn't reapply gelatin until she has printed 4 or 5 layers of gum emulsion. This approach hasn't worked so well for me with continuous-tone pinhole negatives — but seeing Melissa's latest prints on unhardened gelatin, encouraged me to try again, this time with digital negatives. My results were pretty good and where there was freckling in highlights I was driven to make positive digital transparencies and to print from them in titanium white to clean up the highlights. Once there was gum emulsion printed from a negative and a positive, the paper was sized by the gum itself and no more freckling occurred.

My former hardening procedure, however, is as follows. Before the formaldehyde step add an 'f' to the sizing notes. Then, under a fume hood (at UArts) or outdoors, wearing

gloves and eye protection, tongs in hand, standing so that you are not downwind, submerge each sheet in a clean tray containing formaldehyde and water mixed 1:40 (l00ml of 37% formaldehyde to 4000ml of water — or 31/2 oz. to a gallon) for 30 seconds to a minute. Outdoors, keep a sheet of plexi covering the tray, pulling it back just enough to slip the paper in and out. Hold your breath as you drain excess formaldehyde water from the paper into a corner of the tray, cover the tray, and then hang the paper outside on a line overnight. At UArts the paper is hung over the tray in the fumehood until it stops dripping and is then hung directly in front of an exhaust fan to dry overnight. The paper will give off formaldehyde gas for at least 24 hours and should not be brought into your living space until the sweet smell of formaldehyde is gone. Meanwhile, return the remaining formaldehyde/water to a sturdy plastic container with a good screw cap and re-use. (I used the same gallon with occasional replenishment as volume diminishes for over 8 years.) Do not store 37% formaldehyde or the diluted formaldehyde in your domestic space in case a subtle out-gassing occurs.

Repeated brushing can wear down even hardened gelatin. After 3 or 4 layers of emulsion I routinely resize with one layer of gelatin that I harden in formaldehyde. After 6 or 7 layers, if the print is not completed, I apply another coat of gelatin and harden again. Sometimes the slight matte gloss of the hardened gelatin gives a satisfying depth to the image and there is no need to apply another layer of emulsion.

After reading about combining gelatin and formaldehyde in the same tray, I tried it once and found that there was an unacceptable exposure to formaldehyde in the hot gelatin and that the gelatin hardened onto the tray and brushes so that it was almost impossible to remove. I have also read of and tried glyoxal in place of formaldehyde as a hardener of gelatin. The MSDS health warnings of potential damage to the nervous system from glyoxal are even more dire than formaldelyde's and the glyoxal solution must be discarded somehow after each use. When I found that it yellowed my paper and my image printed blurry, I definitely lost interest.

Unpigmented Gum Bichromate Sizing

A second method of sizing, which I discovered on my own, bypasses the gelatin/formaldehyde method. Apply ammonium dichromate by itself, as if making a chromatype, and, while it is still wet, generously brush pure unpigmented gum arabic on the sensitized area and buff it down with soft, dry sponge brushes. I apply the gum after the dichromate to keep the gum as much on the surface of the paper as possible to

promote the sizing effect, but it can be hard to buff easily without some reduction of viscosity which is provided by the still damp dichromate solution. When the paper is dry expose it without a light-resist to any kind of actinic light until the yellow chromium salts barely begin to turn a light beige/tan. This might be 10 seconds in the sun, 40 units in the platemaker, or 1 minute under a sunlamp.

Gently wash the paper without letting the soft gum coating touch anything except cool water until it drips clear water when held in your gloved hand above the tray. Hang the sheet to dry, being very careful not to touch the gum coating which will harden eventually to provide a tough sizing for the paper. This procedure may be performed once for relatively hard papers with internal sizing but needs to be done twice for a porous soft paper such as BFK Rives. The light tan color may be removed before printing begins, with a sodium bisulfite bath, or cleared at a later stage in the gum print — or left on the paper.

Other Sizing

Students have had fairly good results sizing with diluted matte acrylic medium, PVA glue, or gesso. Each of these gluey materials should be diluted to a milky consistency and applied in at least two layers with drying between applications. Image formation varies with different sizings. I've seen gum printed on gesso sizing by Evan Woldow that under a loupe revealed a surface like a white dried mud flat with pigment collected in the cracks. A vivid piquant quality emerged from Evan's work whereas my gum prints with hardened gelatin sizing are more softly luminous.

Last summer I tried using agar agar (seaweed gelatin available in Asian markets), unhardened as well as hardened in formaldehyde, as a sizing for BFK Rives but may not have diluted it sufficiently. A little of the powder goes a very long way. I also tried arrowroot starch but probably needed to cook it more and to harden it as well. More experimentation remains to be done for those who want a vegetarian alternative to gelatin sizing. You may come up with your own way of sizing. Experiment with methocellulose.

Or Not to Size

Now that I have described two rather laborious methods for sizing paper that I both teach and use myself, as well as touching on simpler ways of sizing, I must tell you that I have been shown by Martin Lennon, photographer/printmaker, that a different

approach to the application of gum bichromate emulsion to un-sized paper can result in less staining and freckling in highlights than I would have thought possible. Coming from a lithographic background, I have buffed gum bichromate emulsion onto paper with soft dry sponge brushes, rather like buffing gum arabic onto a stone with clean dry surfaces of cheesecloth. Martin Lennon, instead, uses a Chinese haké brush (white animal hair sewn between wooden paddles) and slowly, gently lays out ribbons of pigmented emulsion onto un-sized BFK Rives. He demonstrated his method to a non-silver class with a layer of lamp black emulsion and Dana Leight, graduate student and teaching assistant at the time, subsequently made gum prints on un-sized BFK, using Martin's approach, with 3 layers of pigmented emulsion. Staining and freckling in highlights was not severe enough to reduce contrast significantly and indeed the faint ghosts of brushstrokes in highlight areas gave character to those passages. I speculate that Martin's and Dana's success on un-sized paper came from the facts that they were using brushes made of animal hair (which I suspect releases flakes of pigment more easily than sponge), that they did not buff the emulsion into the paper fiber as I do, and that they were printing from fairly contrasty negatives. Applied Martin's way in one generous but light stroke, the emulsion sits on top of the paper while mine gets tangled in the un-sized fibers of the paper with my many feathery buffing strokes. I encourage students to try Martin's approach but stand ready to teach sizing strategies when they seem to be needed.

I'm not able to use his approach with my own work since I desire a smoother surface than can be achieved with one stroke of emulsion on un-sized BFK and I usually build my prints in several layers of emulsion.

Registration and Taping

The registration of multiple layers of gum emulsion can be accomplished by eye. First, make corners in pencil where the image should print on the paper. This will help you to cover the image area with emulsion yet maintain uncoated margins for safe handling. If you decide to register by eye, the initial layer of gum should be a dark one (but still sheer enough to allow light to penetrate). This dark emulsion should cover the image area and extend just beyond your marked corners so that it prints the edges of your negative. That way after printing the first layer you can see the four corners of the negative which will help you register subsequent layers by eye. Beginning with a dark layer also tests the efficacy of your sizing. It's better to discover right away if the sizing is adequate than to print two forgiving light layers and then, when you coat with a dark

layer, to have dark freckles of pigment show up in the highlights. Additional dark layers can be printed later on after resizing.

Attach minimal amounts of clear or frosted tape to opposing sides of whatever you are using as a light-resist. The hinges of tape on one side of a light-resist, recommended for easy inspection of cyanotype, vandyke, palladium, or chromatype, don't work so well for gum bichromate. Although printing-out can show that a gum print is sufficiently exposed, sometimes a gum print is perfectly exposed with no sign of printing-out because just enough light was received to harden the emulsion without getting to the tanning stage. This is especially true with digital negatives. Pieces of tape on one side might not attach the negative properly to paper sensitized with gum emulsion which tends to curl.

Even though it is transparent or translucent, the tape may print faintly in gum. With a borderless negative, place the tape so that it overlaps dense parts on edges of the negative; that way, it will scarcely print at all. Use as little tape as possible, especially on the film. A bit more tape surface may be required to attach the negative to the border of a curling print but its tack may need to be reduced by touching it to your finger a few times. This will help prevent gum emulsion from pulling off the borders of the print when exposure is complete and the negative is removed from the print.

Use the penciled corners (which can be extended like X's into the margins in case the emulsion hides the actual corner L's) as a guide for placing the negative for the first exposure. After exposing, developing, and drying the first dark layer, coat the printing paper again with a second emulsion layer of any color you desire — light, dark or in-between — and place it in darkness to dry. When the second layer of emulsion is dry and you are ready to expose it, precise registration is required. Position clear tape on your negative again. Then take the sensitized print out of the dark drying area and tape its four corners with drafting tape (or some other tape that will release cleanly) to a light table that is located in an area with low ambient light.

Turn on the light table and orient the negative on top of the print. Previously printed areas should fill the open areas of the negative. If you see bright yellow edges around opaque parts of the negative, shift the negative to cover those areas or else the new color will print in highlight areas as a thin line around the previously printed layer. You can use a tube of black construction paper placed on top of the light-resist to block out extraneous light for viewing particular parts of the negative on top of the print. Check

the four corners of the image to make sure the negative isn't off-register in one direction or another. If the paper has shrunk and the negative cannot be perfectly registered, decide which segment of the image requires sharp focus and which segment(s), if any, can tolerate a looser registration. After you position the negative as well as possible, hold the negative in place with one hand and press the bits of tape attached to the negative onto the print with the other hand.

Registration by means of pin or needle holes through opposing corners of both the negative and the paper also works. Traditional pin (or button) registration is another option but tends not to work if the holes are on one side of the paper and even very slight shrinkage has occurred. Tabs can be taped to view camera negatives so that holes don't have to be made in the film and I suppose that tabs could be attached to the edges of the print to avoid making holes in the edges of your prints.

Printed registration marks can be specified in the preparation of digital negatives, both desktop and imagesetter. These usually work well but their positions should be indicated in pencil on your printing paper so that you brush the emulsion far enough into the margins of the image for the registration marks to print.

Range of Tones

Let's assume that you have a negative with as full a range of densities as the 21-step scale and that you are building a gum image entirely in layers of lamp black, as described earlier in 'Approaches to Building an Image in Gum'. A refinement on the idea of giving exposures of varying durations to identical layers of lamp black gum might be to prepare 3 or 4 different dilutions of lamp black pigment in gum arabic. The first layer could use the gum with the most pigment combined 1:1 with ammonium dichromate and would get the least exposure so that the 5 steps of separation would occur in the shadow areas, the clearest parts of the 21-step scale. The next layer might contain less lamp black pigment in the gum part of the emulsion and is given enough exposure to have its 5 steps of separation fall in the mid-tone range. Black pigment in a third layer might be even more diluted and could be given much more exposure so that it did its tonal separating in the upper mid-tones and into the highlights. Sometimes an even more dilute layer with an extra long exposure is needed to print into very dense highlights. Through these multiple layers of lamp black gum exposure, and development, a very full tonal range can be extracted from a single black-and-white continuous-tone negative. This slow building of a print may seem like a limitation of the

medium since it is labor intensive, but it is also a strength. Having to synthesize a full-bodied image, which entails making decisions layer by layer regarding pigment dilution and exposure time, forces an analysis of image formation and allows for creative decision-making with each exposure.

A further refinement can be brought to bear by varying the ratios of pigmented gum to dichromate solution from the normal 1:1. If fewer than 5 steps of separation are desired in a layer of emulsion, increase contrast by using 5 parts of pigmented gum to only 4 parts of dichromate solution. (*Too* much pigmented gum will make it hard to spread the thick emulsion evenly.) If more than 5 steps of separation are desired, decrease contrast by using 4 parts of pigmented gum to 5 parts of dichromate solution. (*Too* much dichromate will lower viscosity and highlights may stain or freckle.)

Placing Colors along Tonal Scale

This time, you are exposing through a single black-and-white continuous-tone negative as before, but instead of placing different dilutions of the same color along the tonal scale you are placing different colors in shadows, mid-tones, and highlights. Such an approach can produce images in which everything seems to be carved of the same material bathed in a unifying light with highlights of one color, mid-tones of another, and shadows of yet another. Some of the formal abstract qualities of black-and-white photography are preserved in this way of handling color.

For instance, brush an initial layer of Antwerp Blue gum emulsion onto your printing paper and expose it under your negative with just enough light to harden blue tones onto your paper in the most open shadow areas. After development and drying of that first skeletal layer of blue emulsion, apply a layer of Perylene Maroon emulsion and expose longer through the negative so that maroon mid-tone values adhere and the blue areas turn brown beneath the maroon gum plus tanning. After development and drying the maroon layer, apply a layer of Transparent Yellow emulsion and expose even longer, perhaps much longer, to print into highlights, turning the mid-tones a complex orange and the blue/maroon shadows even browner. A final barely visible layer of Davy's Gray, made of iridescent ground slate, can be given a mega-exposure into the densest highlights which might separate the orb of the noonday sun from the surrounding sky or a spectral highlight from surrounding chrome (that metal again) on an old-fashioned car bumper. Since the layers are formed from transparent watercolor locked into gum arabic, shadow detail can remain visible beneath subsequent layers of more heavily exposed

emulsion. If shadow detail is not visible, it may be due to heavy tan/brown printing-out of the chromium salts. A clearing bath of sodium bisulfite (or sodium metabisulfite or sodium sulfite) could help to reveal those details along with the true colors of your emulsion — aside from the gray/green left by the heaviest tanning even after clearing.

Manipulation by Deletion

Students who learn gum printing before being introduced to other non-silver processes are disappointed to find that the subtractive manipulation they do with gum is impossible with cyanotype, vandyke or palladium. With those processes, chemical solutions are embedded in paper or in some other organic support, but gum bichromate emulsion sits on top of sized paper, immediately after development in water, in a soft raised gummy layer that can be brushed away selectively, at least in highlight and in most mid-tone areas. Selective deletion can give the look of local coloration even though you may be working from a single black-and-white negative.

As the paper dries, however, the gum emulsion becomes hard and impervious. The lattice structure of the chromium crystals grips the dried gum so hard that what was raised is now recessed, and the unprinted highlight areas are in subtle matte relief. New gum layers can be added and manipulated. What is underneath will not be affected. (And as layers build up, the relief of the white areas increases to such an extent that I can recognize some of my prints from the backside. This happens even though I flatten my gum prints overnight, after each layer dries, on foam under plate glass.)

Masking

Another way to achieve an in-color effect is by masking parts of the print-in-progress with pure gum arabic. This idea came to me from reading about rubber cement-like frisket used in the selective toning of silver prints. Brush a sheer layer of unpigmented gum arabic onto the area to be masked on your print. After it dries, brush another sheer layer of pure gum onto the same area and let it dry. Avoid blobby puddles of gum. Then in the normal manner with sponge brushes, apply and buff gum bichromate emulsion over the entire image including the frisketed area and give as little exposure as is needed to adhere pigment where desired. If all goes well during development, the gum mask dissolves and the pigmented emulsion should lift from this area. But you must be warned that if the gum mask is located in a shadow area that gets a major exposure, dichromate in the emulsion may harden the gum mask and it may not release as desired.

Another way of controlling the placement of color involves cutting light-resists in the shapes to be masked. Such masks may be made of rubylith or amberlith film, goldenrod paper, black paper, or anything else that prevents actinic light from reaching the emulsion. When placed directly on top of your light-resist in contact with sensitized paper (directly on top of your negative), such a mask will give a hard-edged, cut-out look. If the mask is taped on top of the contact frame's glass, with the negative against the sensitized paper underneath the glass, light will spread and soften the edges of the mask. If you are exposing with a point light source such as the sun, shift the angle of the contact frame during the exposure to soften harsh shadows. If you are using the platemaker which is another point light source, common sense would dictate not taping a mask on top of the platemaker's glass since during exposure anything on the outside surface of the glass would burn, melt and/or destroy the expensive bulb. Indoor light sources that *would* work with the mask on top of the glass include a black light box and a sunlamp.

In addition to placing color where desired, manipulation and masking may be used to bring out some areas and suppress other areas. Instead of using *opaque* masks, *translucent* materials such as frosted mylar can serve as partial masks to dodge and burn specific areas. Emmet Gowin, the esteemed silver photographer who makes contact prints from view camera negatives, said, in a lecture at The Photography Place in the early 1980s, that he had never made a large format negative with the perfect distribution of light and dark. He showed how layers of frosted mylar can be cut into different shapes and stacked like a contour map to effect a controlled, precise, and repeatable dodging of an image. Sandwiching his view camera negative against a piece of silver gelatin paper beneath plate glass under the enlarger lamp, he placed the layers of mylar on top of the 1/4″ glass. This complex mask allowed varying amounts of light to pass through it to the negative and photographic paper below. I was inspired by Emmet's sharing of this technical information to try the same approach with non-silver processes, especially gum printing, and found that it worked well. But more often I found myself winging it, dodging parts of an image with pieces of cardboard and my hands as the gum layer exposed in the sun for one or two minutes.

Finally, there is now the option of a digital mask that can be printed fairly easily from a desktop printer on inkjet or laser acetate. Complex passages can be selected in Photoshop and feathered edges can be specified in 'radius' so that the mask can be printed in direct contact with the negative on top of the print — or even in direct contact with the print as the only light-resist for a particular layer of gum emulsion. The 'gradient' tool is very handy for large simple masking.

Color Separations

The methods described above permit a fairly comprehensive palette of color to emerge if watercolors that approximate the CMYK process colors (cyan, magenta, yellow and black) of commercial offset lithography are used. Antwerp Blue (Winsor & Newton name) or thalo blue can serve as cyan/process blue (as can a layer of cyanotype brushed either under or on top of gum layers). W & N Quinacridone Magenta is a true magenta and mixed with Permanent Alizarin Crimson gives a good process red equivalent for the M layer. Transparent Yellow (a relatively new W & N color that is warmer and more transparent than cadmium yellow that was used before) works well as process yellow. Lamp Black is good for process black. Oranges (from magenta and yellow), purples (from magenta and blue), and greens (from blue and yellow) plus a multitude of browns and grays are created by printing one layer on top of another.

Some gum workers print, using these conventional process color equivalents, from color separation negatives that can be generated easily in Photoshop after scanning a color image. A small color snapshot can be turned into a large gum print with great physical presence as printmaker Mira Adornetta was the first to demonstrate at UArts using the Scitex imagesetter's maximum format that measures 18″ by 24″. Gum prints made this way do not have to be pale like Beatrix Potter illustrations, although a faded, nostalgic look is easily achieved with a thin layer of each process color.

Gum Bichromate Solvents

While a weak acid sets and hardens a gum print, the solvents to soften and loosen bichromate emulsions are alkalis such as sodium carbonate powder in water, diluted household ammonia, or diluted household bleach. *(Never combine ammonia and bleach since together they produce tear gas.)* There may be times when you wish to brush away a layer or part of a layer of heavily exposed gum bichromate (a risky but occasionally successful operation) or remove dried emulsion from a bristle brush or a graduated cylinder. A little bit of sodium carbonate, available in supermarkets as a washing aid, just a teaspoon to half a gallon, is the odorless way to loosen the tight grip of a bichromated colloid.

Because of this vulnerability to alkalinity, it is recommended that gum prints be stored over long periods of time in mats that do not contain an alkaline reserve (see 'Light Impressions' in "Resources").

What follows is a step-by-step guide to producing a gum print that also serves as a summary:

MAKING A GUM PRINT

l) **Light-Resist:** Devise some sort of negative transparency that is the size of your final image. A negative is needed to produce a positive image because gum emulsion adheres where light penetrates the negative and releases where light is held back.

2) **Printing Paper:** Any paper or surface (see Dana Leight's "Gum Printing on Alternative Surfaces" at end of this chapter) can be tried, though satisfactory results are not guaranteed. The traditional paper for gum printing is sized BFK Rives, but satisfactory results have been obtained with Arches Cover, watercolor papers, Pondi paper from India and other papers too. Prepare paper, if needed, as described earlier.

3) **Pigments:** Select good tube watercolors, such as Winsor & Newton or Grumbacher (or others carried at Utrecht, Pearl or Daniel Smith) in hues you want to use in your print. Cheaper student grade watercolors will sometimes work out nicely but usually there is less pigment per tube and sometimes the colors are not lightfast. Students have made gum prints of great strength and beauty from inexpensive watercolors, but it is yet to be seen how some of the colors, other than black and earth tones, will hold up over time.

Finely ground dry pigments can be mixed with gum arabic, adding a drop or two of a surfactant such as Photo-Flo and a pinch of sugar to facilitate blending. Dyes, in powdered or liquid form, are not recommended. They don't release easily, tend to stain, and later fade. They are also rather hazardous in powdered form.

According to William Crawford in his chapter on "Gum Printing" in *The Keepers of Light*, you should avoid the following watercolors (even from the best manufacturers) because their "permanence and durability are suspect, especially the first six: Carmine, Chrome Lemon, Vandyke Brown (the watercolor, not the process), Chrome Yellow, Rose Carthame, Mauve, Prussian Blue, Crimson Lake, Purple Lake, Gamboge, Hooker's Green Light, Violet Carmine, Rose Dore. Chrome colors may be chemically incompatible with certain organic pigments or with the sensitizer." Also Crawford says to stay away from Emerald Green (which I read, elsewhere, contains arsenic) and which he says should not be mixed with other chemicals.

It is interesting to note that in the years since Crawford's book was published in 1979, many of the colors that he warned about are no longer manufactured by Winsor & Newton. This includes Chrome Lemon and Chrome Yellow that were discontinued because of 'toxicity and lack of permanence'. Winsor Emerald, which took the place of Emerald Green, does not include arsenic in its list of ingredients but I need to test it for compatibility with gum bichromate. I have noted in classes that Winsor Green does not adhere well and that Ultramarine Blue doesn't either and can give off a sulfurous stench when mixed with at least one kind or condition of gum arabic. Otherwise, believe it or not, there is still an ample selection of colors, each with a distinct personality and history, from which to choose.

Some Winsor & Newton colors, that I think complement the palette already available with cyanotype and the tanning effect of dichromate, are: Alizarin Crimson (the new more permanent kind), Quinacridone Magenta, Winsor Red, Bright Red, Light Red, Perylene Maroon, Winsor Violet, Caput Mortuum Violet, Antwerp Blue, Transparent Yellow, Winsor Yellow, Indian Yellow, Winsor Orange, Burnt Umber, Sepia, Neutral Tint, Blue Black, Ivory Black, Lamp Black, Payne's Gray and Davy's Gray. Chinese White (which is zinc white) and Titanium White can be used to lighten dark areas or for printing on dark paper. Titanium White covers better than Chinese White but has a slight yellow cast. Gum artist Melissa Good, who introduced me to Perylene Maroon when it came out, has also recommended Sap Green, Olive Green and even another green known as Oxide of Chromium which she found is compatible despite containing chromium.

You will find that blues, violets, and whites require less exposure time than reds, oranges, yellows and browns. This is because actinic light finds its way through blues, violets, and whites more easily than through colors that act as masks to it. I have not quantified the different times required for each color to adhere because there is leeway in the exposure of gum prints, but I find that I am usually successful increasing or decreasing exposures by 10-20% to compensate for warm or cool colors.

4) **Gum-Pigment:** Try to mix the pigmented gum part of your emulsion ahead of time so it can become thoroughly homogenized, especially if your watercolor is old and dried out. If you are short of time, mix gum with pigment, add the dichromate solution and pour the complete emulsion through a funnel that has a fine mesh screen. You need the watery dichromate solution to speed the passage of the pigmented gum through such a screen. Chunks of undissolved pigment will be held back and prevented from smearing the paper. If your pigment is fresh and the color transparent, don't bother about straining.

To make a supply of gum-pigment that can be used for a few prints, squeeze $^1/_3$ the contents of a small tube of watercolor (such as a W & N 5ml tube) into a little jar with a tight-fitting cap or into a 35mm plastic film canister. Add a very small amount of gum arabic that equals or is less than the volume of the pigment. Mix the pigment and gum with a stick of clean smooth matboard or something comparable and keep adding small amounts of gum until the mixture becomes a slurry. Add more gum and blend until you have about $^1/_2$ of a film can of pigmented gum. Then dip the tip of a clean, dry 1″ sponge brush into it and brush the mixture onto a scrap of the sized paper that is identical in kind and condition to what you'll be printing on. Or lay down a strip of pigmented gum in one stroke with a haké brush on un-sized paper if that is how you intend to work. Then place the scrap of sized (or un-sized) paper in cool water for a few minutes or hold it under a stream of cool running water briefly. It just so happens that if the pigment or its stain remains on the test scrap, the same pigment or its stain will end up in the highlights of your print when a full emulsion, including sensitizing dichromate, is brushed on, exposed, and developed. If this amount of color is acceptable in your highlights and you like the intensity of the brushed out pigment, stop adding gum, but if you want highlights to be white, or nearly white, keep adding gum and making more tests until the pigment does release completely. Of course you will save money on pigment the more you dilute it in gum Arabic, as long as results are satisfactory.

If the color you end up with is less saturated than you wanted, it is possible to strengthen the image by recoating the print (once it has been developed and dried) with the same color and re-exposing it, or by printing over it in a related color so that the two transparent colors, like glazes, create a third color.

I have many little jars of pigmented gum that I use only occasionally. Poisonous pigments such as the cadmiums keep well but sometimes mold forms on top of the more benign colors and I have to lift it out with a stick of matboard. Over time evaporation occurs and I need to add more gum and a few drops of water. A patty of pigment in a watercolor set is pigment in dried gum that can be used for gum printing by immersing it for as long as it takes to dissolve in liquid gum and some water. A tube of dried-out watercolor pigment can be salvaged by slitting it open with a utility blade and soaking the contents in gum and water as long as necessary.

Photography student Emily Rose Chesser made a gum print using a red clay and a gray clay from Cape Cod. We used a pinch of sugar and a few drops of Photo-Flo to help the clay blend with the gum. Both clays printed beautifully in her red-clay/gray-clay gum print.

5) **Safety & Mixing Dichromate Sensitizer:** Before reaching for the bottle of dichromate, put on gloves. Free disposable latex gloves in medium and large sizes are stored beneath the coating table in the non-silver darkroom at UArts and should be used when handling dichromates. For dichromate solution we use sturdy plastic dispensing bottles covered with black tape that will not shatter or spill (much) if dropped or tipped over. Orange crystals tend to form on the top of the dispenser which will offset onto gloves, contaminating them immediately, so I suggest opening the dispenser with a piece of paper towel that you dispose of. If, when you pour out your dichromate solution, some of it drips down the side of the bottle, wipe it off with a damp paper towel.

For those committed gum workers outside of UArts, who are mixing their own dichromate, exercise special caution when handling the dry crystals by wearing gloves, an apron, protecting your eyes, and perhaps wearing a dust mask. Nowadays ammonium dichromate is usually sold in a granulated rather than powered form and is not dusty, thus safer to handle.

I have evolved a simple way of preparing solutions of ammonium dichromate in which I carefully spoon the crystals into a graduated cylinder up to the l ounce line and add tap water up to 15 ounce mark. (Yes, even Philadelphia tap water can be used for dichromate solutions.) You will see a variety of dilutions recommended, some of which are much more concentrated, but I have found my dilution to be as fast as the more concentrated solutions and I certainly believe in using as little of this toxic heavy metal salt as possible. In fact I mean to try using even more diluted solutions. Last summer I began using a saturated solution of potassium dichromate, an ounce by volume in close to 30 ounces of water. Although the exposures took perhaps twice as long I was very pleased with the results. There seemed to be less yellow staining and tanning.

Dichromate solutions should be stored in darkness in brown or opaque containers but can be handled in subdued room light. No safelight is needed nor should one be used since it is hard to work safely in orange or red light with orange liquid. At UArts we use 60 watt tungsten bulbs in clear glass fixtures that hang on the wall about 4 feet above the coating table. However, once the paper is coated it should be dried in darkness and placed only briefly on a dim light table for registration. Sensitivity increases as paper dries and is at its height following exposure, so get the exposed gum print into water ASAP.

After several years, a solution of dichromate will begin to lose its potency. Ideally you will have used it up before it gets old, but if you are stuck with expired solution, do not pour it down the drain. Save it for a hazardous chemical pick-up or take it to a designated place where toxic waste is disposed of as well as it can be. Such information should be obtainable through the phone book or your borough hall or may be online.

6) **Necessary Supplies:** Before you combine pigmented gum with dichromate, make sure the rest of your supplies are assembled. You will need:

1. ***printing paper***, preshrunk & sized if necessary
2. a ***pencil*** for notes & a ***straightedge*** if you are designing a test strip
3. ***tape*** — white artist, drafting, or masking tape to attach the printing paper to the coating table; clear or frosted tape to attach the light-resist to the sensitized paper
4. ***clean, dry 3˝ sponge brushes*** —2 of the new finer #8505 or at least 4 of the older coarser Poly-Brush for each color (Smaller sponge brushes are OK for covering areas less than 8˝ x 10˝ and you may prefer using bristle brushes.)
5. ***disposable gloves*** for handling the bottle of dichromate, for handling the print as it develops, & for washing sponge brushes
6. ***graduated cylinder*** that measures milliliters, 45ml (11/2 oz.) or smaller
7. ***stirring implements*** for homogenizing pigmented gum in jars or film canisters & for stirring mixtures of dichromate solution and pigmented gum in graduated cylinders (We use 6˝ x ≈1/4˝ sticks of scrap rag matboard.)
8. a shallow ***container*** for the complete emulsion that is wide enough for the coating brushes (Plastic bowls or saucers work well and can be reused.)
9. ***tongs or gloves***
10. ***timer***
11. ***masking material*** — rubylith, goldenrod, orange mylar, cardboard — anything opaque & flat with a straight edge to block out light when making test exposures
12. ***tray of cool water*** for the initial still development
13. ***plexiglas or plate glass*** upon which to manipulate the print
14. ***a hose or small watering can*** for clearing the image with a stream of water
15. ***brushes, pieces of sponge, etching blanket, etc.*** for manipulation of the print
16. ***a bigger tray with a Kodak siphon*** or some other arrangement for final washing
17. ***a line with clothespins*** for drying the washed print
18. ***tofu tubs or something like them*** for soaking and washing sponge brushes before emulsion hardens on them

7) **Working Emulsion:** Prepare the working emulsion by adding one part gum-pigment mixture to one part dichromate solution.

Twelve milliliters of working emulsion should make enough emulsion to coat 8″ x l0″ areas on 3 sized pieces of paper. I find that if I am coating 10 or more sheets with 8″ x 10″ image areas, it averages out to 3ml emulsion per print but about 6ml are needed to charge the first brush initially and coat the first print. (To pre-wet the brush in water would lower the viscosity of the emulsion and could make it harder to clear highlights.)

Although the gum-pigment mixture will keep for months, or even years, in a sealed jar, once dichromate has joined it, an inexorable hardening process sets in. This happens even in the absence of light, giving the complete emulsion a working life of usually only a few hours though sometimes longer. To avoid wasting pigment and polluting any more than necessary, learn to prepare only as much emulsion as you will use during a session.

8) **Application of Emulsion:** Pour the blended complete emulsion from the graduated cylinder into a clean, dry container that is wide enough for sponge brushes (or a haké brush) to be dipped into. Make sure, if you are using sponge brushes, that you have a few lined up on the coating table that are dry and soft on the edges. This preparation is to ensure that there is no delay in grabbing a fresh brush during the critical moments just before the emulsion sets up and can't be brushed any more.

Gently, liberally apply all the emulsion you are going to need with the first sponge brush. If that brush ceases to make progress smoothing the emulsion, grab a fresh brush and continue with quick, light strokes up and down and side to side, using one surface of the brush on the upstroke and the other surface on the downstroke. The emulsion begins to set up and will be streaky unless you work fast towards the end. You may sometimes wish for streakiness of emulsion on a print, but you should be able to brush down the emulsion smoothly when you want to. Consider in what direction to make your final strokes if they are going to be at all visible. I tend to think symbolically of horizontal strokes as denoting the passage of time and vertical strokes as gravity.

It is possible to brush complete emulsions of different colors into each other on the same layer but care must be taken to avoid buildup of emulsion where one color ends and another begins — which can result in emulsion sloughing off entirely. It helps when making a transition from one color to another on the same layer to dribble and brush out a line of pure gum arabic with a 1″ brush between the colors which you then brush the colors into from each side.

Another approach is to coat the paper with straight ammonium dichromate and then apply pigmented gum (see 'Two Part Emulsion: Pigmented Gum over Dichromate' earlier in this chapter). This method produces a more contrasty image with stronger colors and makes it possible to apply different colors in patches, but it is harder to coat the viscous pigmented gum evenly without the watery sensitizer present to dilute it. It helps to work the pigmented gum into the dichromate while the latter is still wet.

9) **Drying:** If you have buffed down the emulsion so there are no streaks, the print is nearly dry already. Five or ten minutes of air drying in a dark space with perhaps a few light passes with a hairdryer may be all that is needed to complete the drying. A gum print does not have to be bone dry the way a vandyke brown print does, but certainly dry enough so that it does not offset on your negative and stain it irreparably with dichromate as has happened to students and myself a few times. A wise insurance would be to insert a piece of clear thin acetate between the surface of your gum print and the emulsion side of a precious irreplaceable negative. Also be sure to inspect the glass and base of vacuum tables and other contact frames before entrusting print or negative to them. In a shared space it makes sense to work defensively…

10) **Test Strips and Notes:** Although it is frustrating to be slowed down at this point, taking the time to make a test strip will save time in the long run and will teach you much about the nature and possibilities of the medium. One exposure time cannot be given for every light-resist (negative) for 3 reasons: 1) different film-base-plus-fog densities and other variables in light-resists; 2) differences in the speeds of different colors (i.e. red slower than blue); and 3) your idea with a continuous tone negative of where you want to place the 5 steps of separation on a 21-step scale, i.e. shadows, mid-tones or highlights.

The paper used for the test strip should be identical in kind and condition regarding sizing to that of your final print, but it need not be as large so long as the critical areas of the negative (both highlight and shadow for each exposure on the test strip) can be exposed onto it and there are margins extending beyond the negative where ruled lines and exposure times can be seen without lifting the negative. Design your test strip before applying emulsion to avoid resting your hand on the sensitized paper or possibly fogging the emulsion through prolonged exposure to light. I like to use an HB pencil and a straightedge at least 12″ long to draw lines in the margins.

Find a passage within the negative that includes crucial densities in the parts of the image that matter to you most. With the test paper on top of the negative on a light

table, design the test sheet so that each of the 5 test exposures contains the range of densities that concern you. Your test sheet may end up divided into cells on a horizontal landscape, each frame containing a segment of land and sky — the range of densities that concern you. Or the test strip may be divided into long thin strips in a vertical portrait, each strip recording forehead, eye(s), chin, and neck. Using the straightedge, draw lines in the opposing margins of the test paper to mark the outer limits of the test strip. Within those lines draw 4 more sets of lines in the margins so that there are 5 different areas for 5 exposure times. I avoid drawing lines through the actual image area because the graphite might smear and otherwise obscure slight differences between one time and another. Mark in pencil on the test strip where any corners or edges of the negative are located, for coating and registration purposes.

A good test strip goes from being underexposed to being overexposed to reveal the range of possible exposures for shadow into highlight. Sometimes an exponential progression such as 1, 2, 4, 8, 16 units of exposure runs the gamut of possibilities better than an additive progression such as 1, 2, 3, 4, 5 units, especially with a continuous-tone negative that has dense highlights. Whichever progression is used, write the numbers between the lines on both sides of the area being tested. This will help you place the masking material during the actual exposing of the test strip when the negative will be hiding your image and all you have to guide you in placing the mask are your lines with times in the margins.

When you have coated the test sheet with gum emulsion and are ready to make the test exposure, tape the test strip to the negative and start out giving the shortest exposure to the entire test strip; then cover the part that was to have that minimum exposure and give the rest of the strip the next increment of exposure, advancing the masking material to cover the strip that goes with each exposure time, and ending up with one strip at the end that receives the longest exposure.

You will thank yourself eventually for going to the trouble of making test strips, at least a few times in the beginning, to get a sense of the range of possibilities with the kind of negative you are using. You will also thank yourself for keeping notes on the water-colors used, the exposure light source and duration, the date, and any other pertinent information. I write such notes around the edges of my printing paper and later transfer the information to a notebook if I exhibit, sell or donate the print. Although it is almost impossible to produce a uniform edition of multi-layered manipulated gum prints, you can come close with comprehensive notes or can make informed changes.

11) **Exposing:** Ideally, gum bichromate emulsion should be exposed soon after coating. If coated paper is stored more than a few hours, especially in hot, humid weather, unexposed parts may not release or severe freckling can occur. Heat and time as well as actinic light can trigger the hardening of gum emulsion.

Tape or simply lay your negative, emulsion side down for a right-reading image, against the dry sensitized side of the printing paper (or against a piece of clear acetate that lies on top of the sensitized paper) and place the ensemble in your contact frame so that light shines through the negative onto your paper. If you are making a test strip under a 275 watt sunlamp at 18˝ with a lith or thin continuous-tone negative or an imagesetter or desktop acetate negative, try making a test strip with a sequence of 2-minute exposures up to 10 minutes. With the same negative exposing in a black light box, also try a series of 2-minute exposures. On the platemaker try a series of 20-unit exposures (at least on our machine with its current calibration). In direct sunlight, try 10-second exposures. It is OK to place the opaque test strip mask on top of plate glass, rather than directly against the sandwiched negative and print, when exposing in the sun or under a sunlamp. The light will spread somewhat but with a point light source that casts a strong shadow, differences between exposure times should be visible. Dense continuous-tone negatives, and other light-resists with a wide range of densities require much longer exposures to print highlight detail. A test strip, with exposures that double each time, will be more informative than an additive test strip. Remember that a useful test strip goes from underexposure to overexposure, covering the range of possibilities.

Sometimes a thin negative that would produce a muddy print in vandyke or palladium will print perfectly in gum, but the exposure needs to be precise so that the emulsion hardens and releases where desired. A good test strip comes in handy.

12) **Developing:** Traditional gum development involves immersion of the print face down in 90°F water for about one hour. Gum prints developed this way have a matte surface because most of the gum arabic dissolves out of the emulsion. To have trays tied up an hour for each layer for each gum print, not to mention maintaining 90° temperatures for those trays, is a logistical nightmare in a class situation. Out of necessity I have evolved shorter exposures and a shorter coldwater development. This handling turns out to have aesthetic advantages, in my opinion. More gum arabic is retained on the print, lending a luster as layers build up. The printed areas are in relief as the paper is drying but when completely dry, the unprinted upon, lighter areas appear raised and the printed areas, gripped by the dichromated gum, recede, subtly sculpting the paper.

Using our method of development, slip the exposed test strip (or print) face up into a tray of cool water that is at least 2″ deep. See that the surface of the print is covered with water. Then, wearing gloves (no bare fingers!), lift the print by diagonally opposing corners, turn it over and lower it slowly into the water again, face down. This way of touching the water with the center of the print gives air bubbles an escape route from beneath the paper. Air bubbles leave underdeveloped muddy circles. Avoid having the image area touch the bottom of the tray or anything else because the emulsion is now soft and easily marred. Let the print or test strip soak for a few minutes with occasional gentle agitation and a few careful liftings and flippings to speed the release of unexposed areas.

When water in the tray has grown murky from unexposed ammonium dichromate and pigmented gum leaching into it, lift the print, drain it, and place it carefully in a large washing tray that is elevated enough to accommodate a tray siphon. The tray should have fairly deep water and, ideally, no other prints floating in it. If other prints are already in the tray, watch your print to see that it doesn't get marred — or mar someone else's print. One gum print in the wash tray can be face down and another face up on top of it, but not face to face or face to back. It distresses me to see a delicate gum print being ruined in the final wash through careless handling. However, beginning gum students tend to overexpose their prints so that rough handling during development doesn't always pose a problem for them. But they are producing prints that they had to scrub to clear and which lack the subtlety and sensuous surface that gum is capable of. In any case, in the final wash tray, adjust the water flow so that the siphon begins to remove dirty water while adding clean water, but not so hard that the print is buffeted and crimped.

13) **Manipulating:** After development in water, you can manipulate your gum print if necessary. It is helpful to practice manipulation on a well-designed test strip. Tilt a clean piece of plexiglas or seamed (smooth-edged) plate glass against the closer edge of the sink sloping away from you. Lay the soft-surfaced test strip face up on the smooth support and, holding the print in place with a gloved hand, start gently hosing cool water around its edges with no pressure. Remember that with a continuous-tone negative the length of your exposure will determine where the 5 or so steps of tonal separation that a single layer of gum emulsion can render will land on the continuum between clear and opaque film.

The first segment of the test strip, that is grossly underexposed, will release almost entirely, handled as in the paragraph above.

The second segment of the test strip, that has had minimal exposure, will render only the clearest most open parts of the light-resist — in other words the deepest shadows and other dark parts of the image. Those areas should be able to withstand a gentle flow of cool water. There may be times when you will want a skeletal rendition of a negative. Handle a print with such a delicately adhered image with special care to avoid marring until washing is complete and the print is thoroughly dry and tough.

In the third segment of the test strip, highlights will clear in still water and mid-tones will partially release with gentle cool hosing. This exposure may give the richest rendition of the negative.

With slight overexposure in the fourth segment, highlights may be covered with a veil of pigment that can be removed with a gentle stream of cool water. Some pressure may be added to the stream if the veil doesn't lift. If that doesn't work, warm the temperature of the stream of water.

The fifth segment that is more grossly over-exposed may require a soak face down in warm water. If that doesn't loosen the highlights, try hot water and then sponge brushes. Gentle rubbing with a piece of woolen etching blanket or something similarly abrasive will sometimes release emulsion.

If you have not made a test strip and you end up grossly over-exposing a layer of emulsion onto well-sized paper, try sodium carbonate as described on pages 16 and 32.

If your gum print was reasonably well exposed you can work with a stream of water, sponge brushes, and bristle brushes, selectively removing pigment in the lightly and moderately exposed areas. Fan-shaped brushes help with a seamless removal of pigment.

When Scott McMahon was a student majoring in Photography at UArts, he deleted gum in scratchy, expressive lines with the wrong end of his brush to denote rainfall. Later in his gum work he brushed away parts of layers of emulsion selectively and allowed the brushstrokes to show. Even something as apparently clumsy as a scrap of etching blanket can be used to delete color in broad lines that look like pastel on rough paper as the paper or the previously printed color beneath the layer of pigment is revealed. You will probably think of other ways to manipulate gum.

l4) **Washing:** When you have finished manipulating your print, lift it up by a corner and see if the water that drips off the bottom corner is clear or tinged with orange dichromate and/or the color of the pigment you exposed. If the water is not clear, wash the print some more face down in the large tray with the siphon flowing gently until the print drips clear water. Hang the print from a clothespin to dry and rotate it occasionally. (Don't stretch it tautly between two clothespins or it might dry ever so slightly wider on that end than the other.) Clean up carefully. Graduated cylinders should be rinsed in warm water. If emulsion has begun to dry in the graduate, add some sodium carbonate (or ammonia or bleach) to dissolve it. Soak sponge brushes briefly in tubs of water (tofu containers work well) and keep changing the water until it is clear. Shake the brushes in the sink with a snap to your wrist to get rid of water in the sponges or, if that motion begins to give you carpal tunnel syndrome, press them flat between gloved hands to squeeze out excess water. Dry them flat, stacked like Lincoln logs on tofu containers with no pressure on the ends of the sponges. Never dry brushes, either bristle or sponge, resting on their working ends. They will be splayed, crimped and generally rendered useless.

The dry gum print is tough, safe to handle, and ready to receive new layers without affecting the existing layers. Wash your hands even if you've been wearing gloves.

15) **Clearing a Gum Print:** You must wait until your print is completely dry, preferably overnight, before clearing it in sodium bisulfite to get rid of subtle yellow staining of highlights as well as all but the darkest chromatype underprinting. The mild acidity of this clearing bath allegedly sets (as well as clears) the gum print but I don't think it is absolutely necessary to use this bath if you are happy with an uncleared print or if no underprinting is visible. Be sure to use the sodium bisulfite in a fumehood or outdoors since it has a strong odor that will make you cough. The same is probably true with sodium metabisulfite though I have not used it. Sodium sulfite does not have an odor but more of it is required and it takes longer to clear a print. Whatever you clear with, have a tray of water on hand to stop the action. You may wish to retain some of the warmth of the chromatype underprinting by not clearing it entirely. You can also apply the clearing agent in different concentrations with a brush to certain areas. Be sure to wash the print for a few minutes after clearing so that the acidity of the sodium bisulfite does not remain in the paper fibers.

16) **Presentation of Print:** If you have flattened your print after each layer of printing you can easily mat and frame it. If your print is very curly, do not 'break' it by placing

weights on it or putting it in a drymount press. Instead, spray a fine mist of water on the back of the print to relax the curl and leave the print face up under plate glass on top of foam or some other porous surface until it has dried.

Occasionally there will be white or light spots on your finished gum print which you will wish to bring down in tone. Spotone dyes work well on gum prints, sinking right into the emulsion. From among the 6 Spotone colors that are sold it is possible to find or mix a match with appropriate dilution to spot small areas in gum prints. If these dyes are used to darken just a tiny light spot it probably will not matter if the dye is not entirely archival and changes a little over time. If you prefer to spot with watercolor, add a drop of Photo-Flo or some other surfactant to the watercolor to reduce surface tension and allow the color to sink into the emulsion. The Pitt artist pens by Faber Castell are lightfast. Last year a range of grays, terras, and landscape colors , all with the brush tips, were introduced. I use Pitt pens to spot my gum prints. Mistakes can be sponged off with water on a bit of sponge if the print is covered with tough gum emulsion.

If you are matting your gum print, the issue of where to crop it will arise. Do you allow only the image to show, emphasizing the content of the image and bringing out its pictorial qualities, or do you permit the brushed borders to show, thus emphasizing the process and revealing the individual colors that formed the image? If showing the borders, how much should be shown? Should the print be floated on top of a piece of matboard? If you are cropping the image, do you let the edges of the film show? Can you crop into the image? There are no rules about presentation just as there are no hard and fast rules about how to work in gum. It is up to you to find your own way of working with this complex expressive medium.

17) **The 'Failed' Print:** If you are not happy with your completed gum print, do not throw it away. Your teacher, if you have one, may be able to help you understand what happened and what might help you achieve what you were after. For instance, if your highlights are freckled with pigment from the last layer of emulsion you applied, the problem is that your sizing wore away just where you wanted it to work best. This often happens when the sizing is unhardened gelatin because it is soft and abrades easily; or if you washed your print in water over 80˚, as can happen in the summer, the gelatin simply dissolved and washed away – this does not happen with hardened gelatin. You probably didn't have freckles where previous layers of gum emulsion were already printed because those layers acted as sizing. Or perhaps over-exposure darkened your highlights. Instead of throwing a print with freckled or muddy highlights into the trash

you might print the highlights from a positive transparency in a layer of titanium white emulsion. If you don't already have a full-size positive from making an enlarged negative, a positive can be obtained in the chemical darkroom by contact printing the negative against another sheet of film or in the digital darkroom by scanning the negative and generating a positive on inkjet or laser acetate. You may be pleasantly surprised to recover your highlights and end up with a print that is more interesting than if everything had gone as planned.

Finally, there is no rule (except a self-imposed one) that says you can't draw, paint or collage on a gum print or work the gum print into a larger piece. From apparent failure you may be led into a new way of working.

GUM PRINTING ON ALTERNATIVE SURFACES

by **Dana Leight**

If you have printed in gum bichromate successfully on sized paper, you know that the sizing gives the surface of the paper a 'tooth'. A surface other than paper, such as metal, glass or plastic, can be printed on with gum if given a tooth by sandblasting, sandpaper or an electric sander, grinding with carborundum, etc. Copper and zinc etching plates can be given an acid aquatint if you are familiar with the etching process. As long as you give a surface enough texture for the pigmented gum to adhere to, you can print on it. I have gotten the best results using a sandblaster on both glass and metal (copper, bronze, brass and zinc), but I have printed on aquatinted etching plates, stone, plexiglas and mylar as well.

You can treat the prepared surface as you would treat paper as far as coating and exposing is concerned. When you coat, make sure to brush the pigmented gum in every direction so it gets trapped in all the pits on the surface. After exposing, it is best to leave the piece in a tray of cool water for 15-20 minutes because a long still development will draw out the details. If the image cannot tolerate being rocked in the tray of water or gently hosed after a few minutes, it will be very easily damaged when you try to coat the surface again with another layer. If the image does not slide off during development, gentle hosing should help to clear out the highlights. Unlike a paper print, you can remove virtually any part of the image with a soft sponge brush while it is wet.

It is a good idea to use a hair dryer to dry the piece after development and to then post-expose without your light resist for several minutes — the added exposure to heat and light will help harden the gum layer, preventing damage to the gum as you add more layers. As you add more layers of gum, the tiny pits on

the surface will begin to fill in and eventually the surface will become built up again so that adding more layers will disturb the previous layers — the image will begin to flake off during coating. I have gotten very interesting results by allowing this to happen and even planning for it, so it is not necessarily a negative aspect. Even after post-exposing a dry plate, you can remove parts of the image with water and a sponge brush if you want to. You can also remove an image completely and start over again by repeating the process of giving it a tooth. Once the image is finished, I use Krylon Crystal Clear Acrylic Spray to protect it from moisture and handling. (Zinc plates will oxidize if left in the air unprotected.)

ONE INTERPRETATION OF GUM PRINTING

by **Melissa Good**

I am more than willing to share any information for others to learn and grow from.

Preparation for Negative:
As for my image, I scan a 35mm color negative on a flat bed scanner at 1200 dpi at 100%, do touch-ups in Photoshop, change the image to black & white, invert the image, and adjust the image with curves and sometimes levels.

Printing the Negative:
Try experimenting with different kinds of inkjet transparency films, by purchasing either sample packs or just a few different film packs of various brands, to see which film will work best with your printer and medium you are working in. I initially did test prints with various inkjet transparency films, but the film I have been working with has been discontinued (luckily I have a bit of back stock to work with). When I print out the image, I go to print options and "scaled to fit media" in the Epson dialog box. From an Epson printer, I then print out the image as an "Ink Jet Back Light Film", SuperFine - 1440, Color, Error Diffusion, click on "Microweave and Super" and then print out the image. This is how I get the single negative from which I make an in-color gum print. Through experimentation you may find something that works best for your setup.

I let the ink on the negative dry overnight by hanging it from a clothesline or on a corkboard with pushpins. I have not had a problem with smearing, but if it went underwater I am sure it would smear. I have to say that although I am not the most gentle handler of my negatives, the negatives usually do not get too banged up; however, the most I have used a negative is for 3 different gum prints with varying numbers of layers.

Sizing:
I do not do the typical version of sizing paper. The way I do my paper (BFK Rives) is that I preshrink the paper as described in the gum chapter by Sarah and I let the paper dry completely. I then coat my paper with two layers of gelatin using a sponge brush. The way that I was originally taught was to then soak my paper in diluted formaldehyde, which hardens the gelatin. I have skipped on using the formaldehyde with my prints because of the health hazard of using it (without proper ventilation it is not a good idea to use this chemical). After long discussions on the benefits of using or not using formal dehyde I have come to the conclusion that it is fine not to use formaldehyde as long as you print over top of any gelatin and do not use gelatin as your last layer in gum printing. As for how often I use gelatin between layers, I usually do not recoat my paper with gelatin after the initial coating. Currently my work, has no more than seven to eight layers. In the past I have worked with up to 10 or 12 layers of gum pigment, re-coating with gelatin one to three times throughout the printing process, but I would sometimes end up with crackling in my print, which I attributed to the gelatin layers.

Good luck with gum printing, take notes, allow for accidents and have fun.

CASEIN PRINTING

Information complied by **Rosae Reeder** as taught to her by **Don Camp**

Definition

Casein printing is a non-silver photographic process that works well with dry pigment.

Casein is made by breaking down the protein in milk with ammonia to create a glue-like substance. Pigment is added for color and ammonium dichromate is added to make a surface photo-sensitive.

Types of Negatives

Because ammonium dichromate is the sensitizer, a negative must be used for exposure. A negative can be produced in any number of ways. Some examples are:

- Traditional photo negative – photographs taken, then developed. Make a contact print or expose images to larger negative film (lith film, x-ray film, etc.).

- Inkjet negative – image must be scanned into the computer and output as a negative in grayscale onto inkjet transparency film.

- Hand-drawn negative – using a sheet of acetate or frosted mylar, make a drawing with black medium such as acrylic or ink. (If you are using acetate with liquid medium such as ink, you may need to add a very small amount of Photo-Flo or liquid detergent to break the surface tension and allow the medium to adhere to the acetate.)

Types of Pigment

Any pigment that can be incorporated into this mixture can be used. It is recommended that only water-soluble pigments are used — or dry pigment.

- Watercolor—use less than you might expect to use. If you do not size the paper for these prints, some staining could occur.

- Gouache — can be used instead of watercolor. It is more opaque and also has the possibility of staining.

- Dry pigment — any dry pigment can be used. Store-bought pigments for making oil paints are suitable; common dirt and soil work very well. Xerox toner is quite suitable for making a pleasing gray-to-black. When using the dry pigment, add a little Photo-Flo so that the surface tension of the water is broken. This will allow for better incorporation of the dry pigment.

Making Casein

Materials needed to make the casein are as follows:

- glass jar with lid (mayo or peanut butter jars are good sizes)
- powdered milk or plain large-curd cottage cheese (whole milk or low-fat work)

IF YOU ARE USING COTTAGE CHEESE, SIMPLY FOLLOW STEPS 3 THRU 6 BELOW.

- plastic spoon or stick
- glacial acetic acid (stop bath without the indicator) for use with powdered milk only. (White vinegar can be used in place of the glacial acetic acid but the curdling time can be much slower.)
- old nylon stocking for powdered milk or sieve for cottage cheese
- ammonia, plain
- 2 medium-sized bowls for mixing and straining with powdered milk
- rubber or plastic gloves

Mixing (Gloves should be worn for this procedure.)

1. Mix powdered milk according to the instructions on the box with tepid water. Be sure to mix thoroughly so that all powder has dissolved.
2. Add glacial acetic acid to the mixture until it begins to curdle. Try to obtain large curds if possible by pouring a little of the acetic acid in at a time.
3. When the mixture curdles enough, place the curds in the old nylon stocking (or a sieve for cottage cheese) and squeeze out as much liquid as possible. The squeezing should be done while rinsing under cold water. Continue to rinse until the water runs clear through the stocking (or sieve) and curds.
4. Open the stocking and place the curds in a jar. Make sure you have squeezed out as much water as possible.

5. Cover the curds with ammonia. Be sure to push the curds down into the jar so tha they are totally covered with ammonia. (The thickness of this liquid will depend upon how much ammonia you add to the curds. If you are using dry pigment, I recommend a thicker mixture because this will allow you to create heavier textures and it will allow those heavier areas of pigment to adhere to the paper better. The thinner mixture with dry pigment added, will give you some reticulated marks where the pigment has rested.

6. Let the ammonia and curds mixture sit for at least 24 hours uncovered in a cool dry place. In front of an open window with minimal light coming in or high on a shelf are good places.

This mixture is now suitable for incorporating the ammonium dichromate and pigment.

Coating the Paper

Many different types of paper can be used for this process as long as the paper can be immersed in water and soaked for a period of time without disintegration. Printmaking papers are highly recommended.

Use a small dish for mixing the casein, pigment and dichromate for coating paper.

- Add some of the casein mixture to the dish.

- Add your choice of pigment. If you are using the dry pigment remember to add a little Photo-Flo as well (just a couple of drops). REMEMBER, the intensity of the color is determined by the amount of pigment used. Also, try not to go too heavy on the first layer. Exposure times might need to be lengthened if your coating is too dark. AND if you go too dark on the first layer, difficulty in achieving multiple layers of exposure may arise.

- Add the dichromate mixture (see "Gum Bichromate" chapter under 'Safety and Mixing Dichromate Sensitizer'). You could measure one to one, dichromate to casein.

- Mix well and coat paper with a soft wide bristle brush. Haké brushes work well for this. The casein can be a bit thick and you want to use a brush that can grab the mixture and coat evenly without too many passes.

- Let the coated paper dry thoroughly in a dark area before exposure.

Exposure Times

Exposure time will vary depending on your medium of exposure, coating of the paper, and pigment used. A test is required to get the best result per negative. These prints can be exposed anywhere from 10 seconds to 1 hour. The exposure time for casein can be much faster than gum or other non-silver processes. Be sure to take this into consideration while testing for exposure times.

Developing the Prints

Casein prints should be developed in water.

- Fill a tray large enough to accommodate the print in with water.
- Immerse the print under the water image side down. This is done so that the pigment and the casein will fall off of the paper as the casein is permeated by the water.
- Developing can be pushed by removing the paper from the water and going over the image area with a stream of water. If that doesn't clear the image, let it sit wet on a horizontal surface for a couple of minutes, and then stroke the image lightly with a soft wet brush, then a hard bristle brush or fingers (with gloves). Be careful with scrubbing the surface of the print so as not to remove important parts of the image or paper fibers.
- Once the print has been developed, hang to dry.

Layering effects seem to achieve the best results with this process. Experimentation and exploration of assorted pigments, thickness of the casein mixture, different types of casein (cottage cheese, powdered milk), assorted papers and exposure time will all lend to the many different effects that can be achieved.

RESOURCES

There have been many requests for sources of chemicals, films, papers, and other supplies for non-silver processes. The large chemical companies are not allowed to sell certain chemicals to individuals without some kind of institutional letterhead. The following pages list smaller suppliers who will sell to individuals.

I discourage the accumulation of toxic chemicals in the home, especially where there are children. Try not to order more of a chemical than you are certain to use because it is even harder to safely dispose of hazardous materials than it is to acquire them. If you plan to print in non-silver in a home studio, under no circumstances should it be done in the kitchen and preferably not in the bathroom either. Proper disposal of chemicals makes a difference in the environment and is a moral issue. Damage can be done to water quality and waste water systems by improper dumping of some of these chemicals.

Bostick & Sullivan, in Santa Fe has always been our supplier of palladium chemicals. Out of the recent economic turmoil it has now emerged as the most reasonably priced, competent supplier of all our non-silver chemicals. This family-owned business has a toll free number and can be reached on weekdays between 9:15 A.M. and 4:30 P.M. Mountain Time to answer technical questions. You can download their catalog and also log onto their Alt Photo Discussion Group. They offer workshops and sell many good books along with various papers and films. Melody Bostick recently gave me the welcome news that the $25-$35 hazardous shipping fee for certain chemicals such as dichromates has been lifted now that the chemicals are shipped by UPS ground. Her husband Richard Sullivan is a serious photographer who has done important historical research, advancing the art of palladium and carbon printing.

Utrecht Art Supply at Broad and Spruce in Philadelphia is our nearby school source of BFK Rives, the traditional paper for printing in gum bichromate. BFK can be purchased at a discount in single sheets and further discounted packs of 25 sheets. This local branch of **Utrecht** stocks hard-to-obtain Arches Platine paper at a reasonable price especially for our non-silver classes. Lots of other useable papers as well as Winsor & Newton Artists' Water Colours and other good watercolors are available and discounted in all Utrecht stores.

Freestyle Sales Co. sells inexpensive Arista-II Ortho Litho Film film that works well.

Although the sun is free and a powerful source of actinic light, a reliable indoor UV light source is a necessity for some non-silver printers. Photographers Jesseca Ferguson of Boston and Ernestine Ruben of Princeton are very pleased with their exposure units

from **Edwards Engineered Products** at www.EEP" www.EEPJON.com. Jon Edwards also sells coating rods, which help to conserve precious palladium chemistry.

Through the **Alternative Processes List** that I joined in January 2000 and left in August 2001, my knowledge of non-silver deepened considerably. People from all over the world, with backgrounds in every area imaginable, generously contribute wisdom gained through experience. It is possible to peruse the archives of this list by subject matter (thread) as well as date and contributor at Alt-Photo-Process Archives.

To subscribe to the alt-photo-process mailing list send an email to:
alt-photo-process-request@usask.ca
with the message: <subscribe alt-photo-process-L>

To unsubscribe from this list send a message to the address:
alt-photo-process-request@sask.usask.ca
with the message: <unsubscribe alt-photo-process-L>

Judy Seigel, who is a major contributor to the Alt-Photo List, produced *The World Journal of Post-Factory Photography.* Issue #1 came out in April 1998 & the final Issue #9 in April 2004. It is highly recommended that the serious non-silver photographer obtain a set of these invaluable, very reasonably priced journals while supplies last. They are almost certain to become collectors' items:

Post-Factory Press
61 Morton St.
New York, NY 10014

E-mail: **info@post-factory.org**

Malin Fabbri in Sweden has been a vital force in the non-silver realm for nearly 10 years with her well-designed, comprehensive Alternativephotography.com website. She features an extensive gallery of work by non-silver artists from all over the world, an online bookstore (which carries her books *Blueprint to cyanotypes, From pinhole to print*, this manual, and lots more). There are free *How-To* descriptions of non-silver processes with relevant books listed. Also there is a *Forum* for discussion and sharing information, a *Facebook* page and a *Newsletter*. Malin is friendly and accessible.

PRICES ARE FROM JULY 2010

Bostick & Sullivan
P.0. Box 16639
Santa Fe, NM 87506
Website: www.bostick-sullivan.com
Email: melody-bosticksullivan.com
Helpline: (505)474-0890 Weekdays 9:15 am- 4:30 pm Mountain Time;
Toll Free (877) 817-4320

Palladium Printing Chemicals:

Solution A #1 (palladium)	25ml	$8.75	100ml	$27.50
Solution B #2	25ml	$8.75	100ml	$27.50
Solution C #3	25ml	$59.95	100ml	$189.00
Na2 20% Sodium Chloroplatinate 10ml	10ml	$80.00	25ml	$199.00
B&S Ammonium Citrate Developer	1qt	$15.00	1 gallon	$50.00
Potassium Oxalate Developer	1qt	$15.00	1 gallon	$55.50
B&S Clearing Agent EDTA	1000gm	$30.00	5000gm	$130.00
Sodium Sulfite	1000gm	$10.00	5000gm	$25.00

Gum Bichromate Supplies:

Ammonium Dichromate	100gm	$16.00	500gm	$72.00
Potassium Dichromate	100gm	$10.25	500gm	$43.75
Gum Arabic Solution 14 Baume	100ml	$5.00	500ml	$13.00
Sodium Bisulfite	250gm	$5.00	1000gm	$12.00

Cyanotype Chemicals:

Ferric Ammonium Citrate	250gm	$14.00	1000gm	$39.50
Potassium Ferricyanide	250gm	$8.00	1000gm	$22.95
Sodium Carbonate	250gm	$4.50	1000gm	$8.00
Tannic Acid	100gm	$11.00	500gm	$44.00

Vandyke Brown Chemicals:

Silver Nitrate	30gm	$28.99	100gm	$70.00
Ferric Ammonium Citrate (see above under cyanotype)				
Tartaric Acid	100gm	$11.00	250gm	$15.00

Edwards Engineered Products
Jon Edwards
5304 Arrowhead Drive
P.O. Box 4461
Lago Vista, TX 78645-4461
Website: www.eepjon.com
Email: jone@eepjon.com
Voice: (512) 267-4274 Fax: (512) 267-4274

UV Light Sources for Platinum/Palladium Printers (and all other non-silver processes)

11″ x 14″	$615.00
14″ x 16″	$755.00
18″ x 20″	$995.00
20″ x 24″	$2765.00
24″ x 30″	$3220.00

Coating Rods for Platinum/Palladium Printers in 5 sizes.

Freestyle Photographic Supplies
5124 Sunset Blvd,
Los Angeles, CA 90027
Website: www.freestylephoto.biz Open 7 days a week, minimum. order $25
Toll Free (800) 292-6137 Toll Free Fax (800) 616-3686;

Arista Ortho Litho Film (orthochromatic lith film) in a wide range of size comparable to Kodalith type III; five examples:

#525104	10″ x 12″/100 sheets	$76.99
#525114	11″ x 14″/100 sheets	$95.49
#522124	12″ x 18″/100 sheets	$185.99
#522163	16″ x 20″/50 sheets	$136.99
#522200	20″ x 24″/10 sheets	$54.00

Light Impressions
P.O. Box 2100
Santa Fe Springs, CA 90670
Website: www.lightimpressionsdirect.com
Toll Free: (800) 828-6216 Toll Free Fax (800) 828-5539
Storage and matting materials including Westminster Non-Buffered
inkjet media & inks (warrantees are voided with printers if proprietary inks are not used)

Utrecht Art Supply
33 Thirty Fifth Street
Brooklyn, NY 11232

BFK Rives - white (250 grs.)	22″ x 30″	1 sheet $4.99	25 sheets $93.80
BFK Rives - white (280 grs.)	22″ x 30″	1 sheet $5.89	25 sheets $
Arches Platine	22″ x 30″	1 sheet $6.29 only at Broad & Spruce, Phila.	

Winsor & Newton Artists' Water Colours—Ask for brochure listing new & discontinued colors 2002; see page 8 for a listing of colors that have and haven't worked for us.

Series 1 W&N	5ml tube	$6.69	14ml tube	$11.19
Series 2 W&N	5ml tube	$7.59	14ml tube	$12.59
Series 3 W&N	5ml tube	$8.49	14ml tube	$13.49
Series 4 W&N	5ml tube	$9.99	14ml tube	$17.49

Recommended Periodicals & Books

Judy Seigel, The World Journal of Post-Factory Photography, Post-Factory Press, 61 Morton Street, New York, NY 10014 < HYPERLINK "mailto:info@post-factory.org" info@post-factory.org>

Christopher James, The Book of Alternative Photographic Processes, Delmar, 2008 2nd Edition

Lyle Rexer, Photography's Antiquarian Avant-Garde: The New Wave in Old Processes, Abrams, 2002

Eric Renner and Nancy Spencer, editors, Pinhole Journal, Pinhole Resource, Star Route 15, Box 1355, San Lorenzo, NM 88041 <pinholeresource.com>; (no longer published but wonderful back issues available)

Philip Ball, Bright Earth: Art and the Invention of Color, Farrar, Straus and Giroux, 2001

John Barnier, ed., Coming Into Focus, San Francisco Chronicle Books, 2000

Dan Burkholder, Making Digital Negatives for Contact Printing, Bladed Iris Press, Second Edition, 1999

Mike Ware, Cyanotype: The History, Science and Art of Photographic Printing in Prussian Blue published by the Science Museum and the National Museum of Photography, Film & Television, London, 1999

Randall Webb & Martin Reed, Spirits of Salts, London, Aurum Press, 1999

Eric Renner, Pinhole Photography: Rediscovering a Historic Technique 4th Edition 2008

Susan Shaw, Overexposure: Health Hazards in Photography, NY Allworth Press 1991

Larry Schaaf, Sun Gardens: Victorian Photograms by Anna Atkins, Aperture, 1985

William Crawford, The Keepers of Light: A History & Working Guide to Early Photographic Processes, Morgan & Morgan, 1979

Nancy Rexroth, The Platinotype, Formulary Press, Missoula, MT, 1977

Bea Nettles, Breaking the Rules: A Photo Media Cookbook, Light Impressions 1977

Rutherford J. Gettens & George Stout, Painting Materials: A Short Encyclopaedia, Van Nostrand 1942, Dover, 1966

A limited selection of Winsor & Newton Artists' Water Colours used with success by students and myself for Gum Bichromate printing — least expensive Series 1 unless otherwise noted:

004 Alizarin Crimson (old Series 1 & new more permanent Series 3 – mix w. Quina cridone Magenta for Process Red when printing the M layer of CMYK or cyan, magenta, yellow & black))
010 Antwerp Blue — process blue equivalent
034 Blue Black
042 Bright Red
056 Brown Madder
074 Burnt Sienna
076 Burnt Umber
125 Caput Mortum Violet (Series 2)
142 Charcoal Grey
150 Chinese White — zinc white
217 Davy's Gray
285 Gold Ochre (Series 2)
317 Indian Red
319 IndianYellow
322 Indigo — sometimes sloughs off
331 Ivory Black
337 Lamp Black — process black
262 Light Red
422 Naples Yellow
430 Neutral Tint
447 Olive Green
465 Payne's Gray
503 Permanent Sap Green
507 Perylene Maroon (Series 2)
538 Prussian Blue — can slough off
543 Purple Madder
545 Quinacridone Magenta (Series 2 purer magenta hue than Permanent Magenta)
554 Raw Umber
609 Sepia
644 Titanium White
678 Venetian Red
724 Winsor Orange

726 Winsor Red
733 Winsor Violet
730 Winsor Yellow — cold, greenish
653 Transparent Yellow —(Series 2 relatively new warm, transparent, process yellow equivalent)
744 Yellow Ochre

Expensive, used with success by students
137 Cerulean Blue (Series 3)
178 Cobalt Blue (Series 4)
190 Cobalt Turquoise (Series 4)
459 Oxide of Chromium (Series 3)
547 Quinacridone Gold (Series 3)

Expensive, Poisonous and Opaque (all Series 4) use Series 1 or 2 equivalents if possible

Cadmium colors

Discontinued, Incompatible with Dichromate, Fugitive, or Otherwise Problematic
127 Carmine
158 Chrome Lemon
205 Crimson Lake
263 French Ultramarine — often sloughs off, smells sulfurous with some kinds of gum arabic